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SCIENCE

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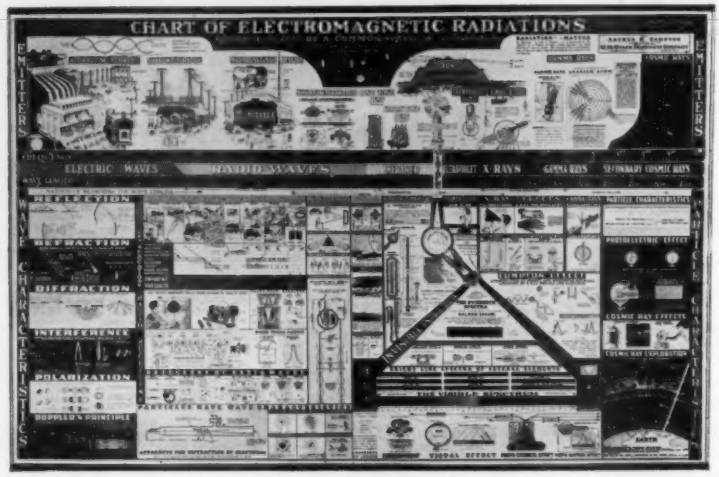

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National Science Policy

OVER the past several months I have talked to many scientists from all parts of the country, and I have been struck by their interest in the plans of the National Science Foundation for developing national science policy. In its basic legislation the foundation is given definite directives in this area.

Scientists, however, are not alone in their interest in the science policy phases of the program. In his 1953 Budget Message the President said,

> The National Science Foundation has been established as the government agency responsible for a continuing analysis of the whole national endeavor in basic research, including the evaluation of the research programs of other Federal agencies. On the basis of studies now under way, the Foundation will formulate a broad national policy designed to assure that the scope and the quality of basic research in this country are adequate for national security and technological progress.

The Congress also has expressed interest in the policy phase of the foundation's activities. In the hearings before the Appropriations Committees of both houses members repeatedly ask about this aspect of the foundation's plans and program.

Success in developing national science policy, in finding the most likely avenues of progress in science, in assessing our research needs, and in over-all analysis of our present research activity will depend in the first instance on scientists themselves. No one else has their intimate knowledge of what science is and should be doing, or their understanding and insight into the nature of the problems of research.

The foundation, therefore, must find appropriate methods for bringing this special knowledge to bear upon its developing policies. We have gone about this in several ways. Members of the divisional committees have been chosen for both their breadth and depth of understanding of science and its relation to other aspects of our national life. For advisory consultants we have drawn upon many of America's foremost scientists, who have had wide experience in teaching and research, and many of whom have been associated with industrial and government research as well. At the present time we are discussing with a leading society a plan, proposed by the society itself, to review the present and potential research activities in its field, to survey its trained manpower resources, and to study the relationship of this field to science and education in general. No matter how this particular study may be carried out, we believe that from such pilot studies may come definite techniques for utilizing the ideas of scientists in building a strong national research policy.

Development of policy for federally supported basic research programs is fully as difficult. Existing programs have not grown haphazardly. They have a definite reason for being, usually closely tied to the operating responsibilities of the agencies. Adjustments in these programs must be made in light of these responsibilities. At the same time, we dare not devote our entire national research capacity exclusively to these specific ends, however urgent they may appear to be. It is here that the foundation is expected to make well-thought-out, systematic policy decisions.

Some forward steps have been taken. The 1953 federal budget estimates contain certain adjustments in the research budgets of the various agencies. The proposed increase from $1.4 to $8.8 million for research support by the foundation was taken into account in arriving at recommendations for basic research programs for the Department of Defense and other agencies. Similar care was taken in preparing the graduate fellowship estimates.

In initiating or recommending actions relating to national policy the foundation assumes great responsibility for making sure that the research requirements of the nation are met. Our goals must be wisely selected and attainable, and we must see to it that nonscientists everywhere, including those in the Congress, understand the need and urgency of their achievement.

ALAN T. WATERMAN
National Science Foundation

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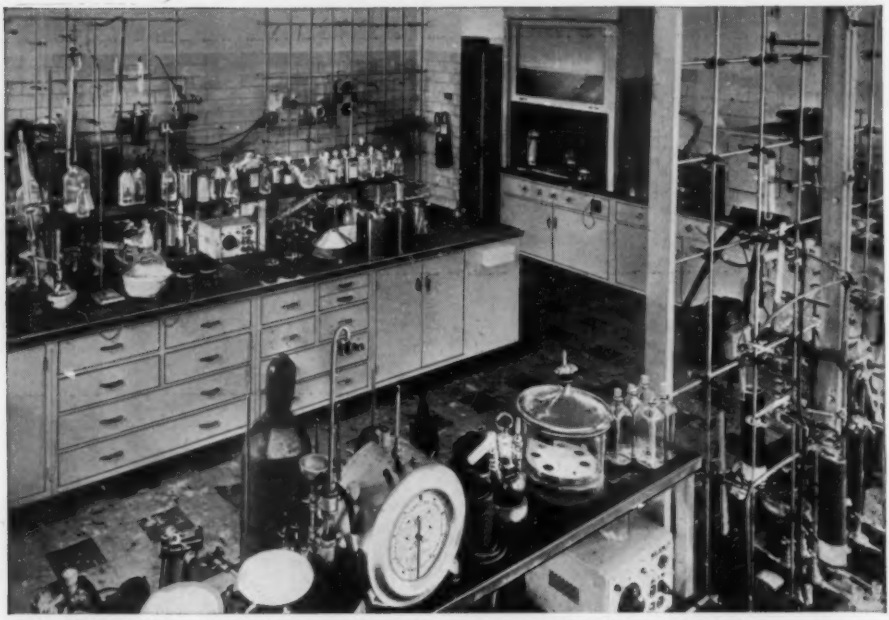

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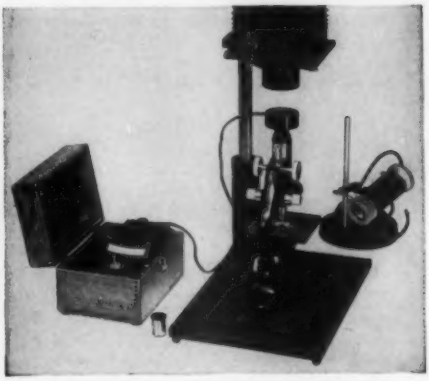

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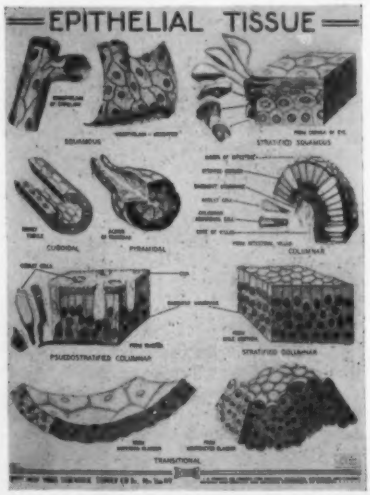

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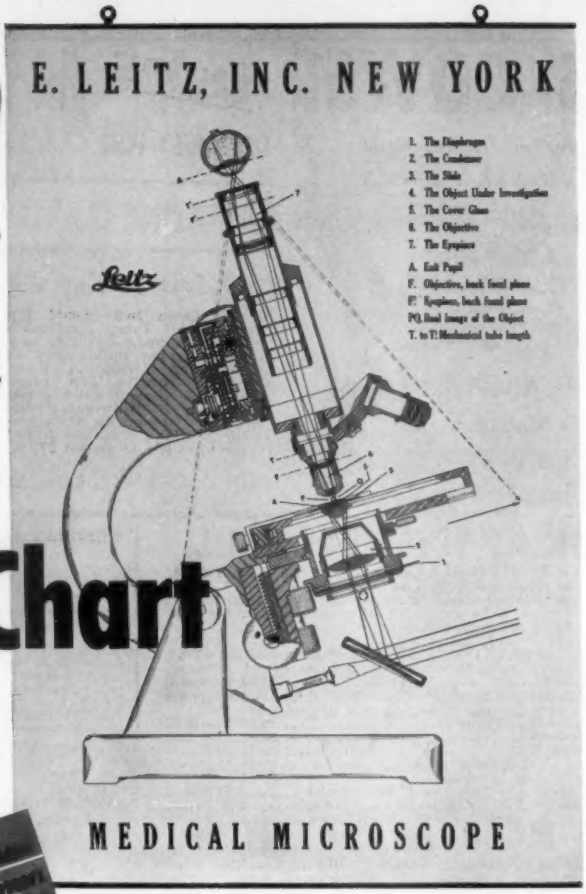

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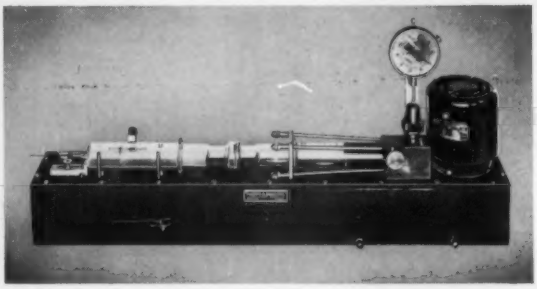

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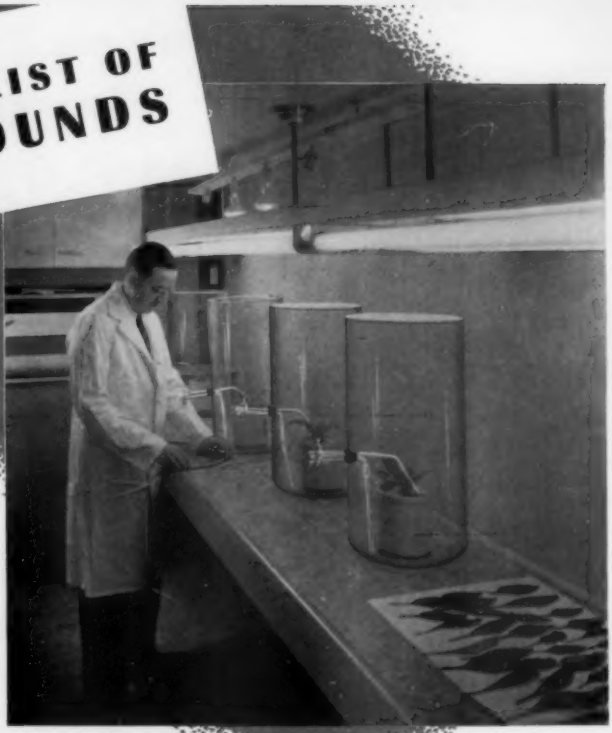

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Otto Meyerhof: 1884–1951

David Nachmansohn, Severo Ochoa, and Fritz A. Lipmann

Department of Neurology, College of Physicians and Surgeons, Columbia University, New York; Department of Pharmacology, College of Medicine, New York University Bellevue Medical Center; and *Department of Biochemistry, Harvard Medical School, Boston, Massachusetts*

WITH THE DEATH of Otto Meyerhof on October 6, 1951, the world lost one of the most outstanding scientists of this century. The revolutionary character of his thinking, the originality of his approach, and the brilliance of his experimental work had a profound influence upon the progress of physiology and biochemistry—indeed, upon the progress of biology as a whole, and consequently upon the medical research of the past few decades.

The significance of Meyerhof's scientific work cannot be appreciated without an understanding of the breadth and richness of his rather unique personality. To many biologists it may be surprising not only that Meyerhof graduated, in 1909, at the University of Heidelberg as a doctor of medicine, but that his thesis dealt with a problem in psychiatry. In fact, at that time he was mainly interested in psychology and philosophy. During this period Meyerhof was closely associated with a group led by Leonard Nelson in Göttingen, whose teaching largely followed Kant and Fries, although with some modifications. He had first come in contact with Nelson during his high school days. His serious concern with philosophy is further indicated by the fact that he was for many years editor of the *Abhandlungen der Friesschen Schule*, where Nelson and his group published.

Following his graduation he entered the medical clinic of Ludwig Krehl, an outstanding pioneer in promoting the introduction of physiological thoughts and methods in the approach to medicine. Krehl's book *Pathologische Physiologie* is considered by many to be a landmark in modern medicine. In Krehl's clinic Otto Meyerhof and Otto Warburg, who were to be the most prominent biochemists of our time, first met. This meeting, which had considerable influence on the subsequent development of these two men and of biochemistry, was essential in stimulating Meyerhof's interest in what was to be his lifework. In the following years Meyerhof and Warburg worked repeatedly at the Marine Zoological Laboratory in Naples and collaborated in studies on the metabolism of sea-urchin eggs. In those days the Naples laboratory was a meeting place for biologists from all parts of the world, as the Marine Biological Laboratory at Woods Hole is today.

An illuminating insight into Meyerhof's early approach to the study of life processes is given by his article "Zur Energetik der Zellvorgänge," delivered in 1913 as a lecture at the University of Kiel, which he had just joined as a *Privatdocent*. This paper clearly shows that his approach was essentially intellectual and philosophical. It reveals also the extraordinary depth of his knowledge and his remarkable ability to integrate a variety of physical, chemical, and biological phenomena.

At the turn of the century there was considerable interest in the question of whether the heat evolved by the animal body could be accounted for by the energy liberated through combustion of foodstuffs. Meyerhof was not satisfied with a merely affirmative answer to this question; he wanted to know how the potential energy of foodstuffs is made available to the cell. He recognized that between the initial energy input, in the form of foodstuffs, and its final dissipation as heat a series of energy transformations may occur. These transformations may serve to maintain the living organisms in the living state, which he clearly recognized as a dynamic equilibrium. It is easy to imagine that these ideas, which became the basis of his lifework, would produce a profound impression in the whole scientific world. Jacques Loeb invited him to write a somewhat enlarged version of the above-mentioned paper for his "Monographs on Experimental Biology." It appeared in this country in 1924 under the title "The Chemical Dynamics of Life Processes." The ideas expressed in this essay are so much alive today that it is still highly recommended to biology students at Harvard as an introduction to the physicochemical approach to the study of life processes.

When Meyerhof approached the problem of the conversions of chemical energy in the living cell, he chose muscle as the experimental material. This choice was prompted by the recognition that muscle offered an excellent opportunity to correlate chemical transformations with the production of both heat and mechanical work.

When he started these investigations, the formation of lactic acid, demonstrated by Fletcher and Hopkins in 1906, was about all that was known of the chemical reactions associated with muscular contraction. The source of this compound, the way in which its formation provides energy, and the manner in which the energy is utilized were completely obscure. A. V. Hill's measurements of heat production by isolated frog

muscle during activity and subsequent recovery had demonstrated, not only that the heat evolved was proportional to the work performed, but also that about half the total heat was actually evolved during recovery. Meyerhof demonstrated that muscle glycogen is the precursor of the lactic acid formed in the absence of oxygen. He further showed that, in the presence of oxygen, some of the lactic acid formed during the anaerobic contraction was oxidized, but that not all the lactic acid underwent this fate. About one fifth to one fourth of it was oxidized to carbon dioxide and water, and the energy of this oxidation was used to reconvert the remaining four fifths or three fourths to glycogen. His discovery thus confirmed and extended Pasteur's hypothesis that fermentation (or glycolysis) is *"la vie sans air"* in that, to a certain extent, it substitutes for respiration. His observations actually proved Pasteur's assumption that less carbohydrate is consumed in the presence of oxygen than in its absence. The depression of glycolysis by respiration has since been referred to as the Pasteur-Meyerhof effect. Meyerhof's brilliant analysis of the glycogen-lactic acid cycle and its relation to respiration explained the course of the heat production and, for the first time, established the cyclic character of energy transformations in the living cell. For this accomplishment Meyerhof received the Nobel prize in physiology and medicine in 1923 (when he was only 39 years old), together with his colleague and friend A. V. Hill.

If we look back on this period today, we realize that it was just a beginning for Meyerhof. In 1925 he succeeded in extracting the glycolytic enzyme system (the system of catalysts responsible for the conversion of glycogen to lactic acid) from muscle, as Buchner and Harden and Young had previously done with yeast. This accomplishment proved to be the turning point in the elucidation of the entire process of glycolysis. He had already recognized the biological importance of the work of Harden and his associates and of Neuberg on yeast fermentation. In a series of studies in 1917 and 1918 he discovered the ubiquitous presence of Harden's fermentation coenzyme (cozymase) in animal cells, and in a classical paper entitled "Ueber das Gärungscoferment im Tierkörper" he described this finding and discussed the significance of the coenzyme in cell metabolism. Here the beginnings of his ever-increasing conviction of the fundamental unity and similarity of metabolic processes throughout the living world can already be seen.

The clarification of the nature of energy transformations in muscle and of the basic mechanisms of glycolysis was enormously stimulated by the discovery of two phosphorylated compounds in muscle: phosphocreatine (Fiske and SubbaRow, 1926; P. Eggleton and G. P. Eggleton, 1926) and adenosine triphosphate, now widely known as ATP, isolated simultaneously a few years later by Lohmann in Meyerhof's laboratory and by Fiske and SubbaRow. One of Meyerhof's most important contributions was the discovery of the high-energy content of these compounds, which he found by measuring the heat produced when they are hydrolyzed with liberation of inorganic phosphate. This discovery revolutionized current concepts of muscular contraction and cellular metabolism.

The enzymatic breakdown of phosphocreatine and ATP in muscle was soon recognized to yield energy for muscular contraction more directly than does the production of lactic acid. For this development a discovery by Lundsgaard was essential. Lundsgaard found that muscles poisoned with iodoacetic acid can contract, without producing lactic acid, at the expense of phosphocreatine breakdown. Further observations in Meyerhof's laboratory, both on muscle extracts and on the intact muscle, demonstrated that the breakdown of ATP precedes that of phosphocreatine and is the process that serves as the primary source of the energy for muscular contraction. The sequence of the various chemical events in contracting muscle was analyzed by Meyerhof and his associate in a most elegant way by employing sensitive physical methods (transmission of light, volume, and pH changes) that could be correlated with the different chemical reactions. These studies culminated in the conclusion that both lactic acid production and phosphocreatine breakdown participate indirectly in muscular contraction by making possible the resynthesis of the ATP utilized during muscular activity. These investigations are a classical example of the successful use of physical and chemical methods in the analysis of cellular function.

Meyerhof's conviction that the same fundamental mechanisms are used repeatedly in nature persistently led him to study the occurrence of important reaction patterns in various phyla. His interest in comparative biochemistry led to the discovery of phosphoarginine in the muscle of invertebrates, where it replaces phosphocreatine and performs the same function.

Although phosphocreatine and phosphoarginine were found to participate exclusively in the metabolism of muscle, ATP is now known to participate widely in reactions involving energy transfer in all cells: its energy can be converted to mechanical, osmotic, and electrical work, as well as into light energy, and can be used to promote a number of synthetic reactions not only in carbohydrate metabolism but in nearly all biosynthetic processes. The discovery of ATP thus was the key that opened the gates to the understanding of the conversion mechanisms of metabolic energy. The reconstruction *in vitro* of the complicated chain of reactions of glycolysis and alcoholic fermentation, in which ATP plays an essential role, is one of the most outstanding achievements of modern biochemistry. Meyerhof's name is inseparably associated with this development, along with the names of Harden, Young, Robison, Neuberg, Parnas, Embden, Warburg, D. M. Needham, and the Coris, among others.

In discussing the mechanism of resynthesis of ATP through the oxidation-reduction reaction of glycoly-

sis, Meyerhof created the expression "energetic coupling" between oxidation and phosphorylation. The mechanism of the coupling was eventually elucidated through the work of Warburg, who demonstrated the generation of carboxyl-phosphate in the process of oxido-reduction.

Today this step-by-step development of the intermediary reactions of the glycolytic cycle stands out as one of the greatest of Meyerhof's accomplishments. Starting with the analysis of the chemical changes associated with muscular contraction, and going deeper and deeper into the analysis of the basic mechanisms involved, he eventually obtained the answer to the question he had raised in his youth when he lectured on the dynamics of life processes. He showed that metabolic energy passes through a series of transformations that make it available for the energy-requiring processes of the cell. Many types of cells can obtain the necessary energy exclusively through glycolysis or fermentation, whereas other cells can, in addition, use respiration as a more efficient source of metabolic energy. As is now known, the utilization of metabolic energy through respiration or through glycolysis occurs in essentially similar ways. Thus the analysis of the glycolytic cycle was the clue to the understanding of the fundamental mechanisms of energy generation in all living cells.

In the midst of his most active and creative period, political events forced Meyerhof to leave Germany in 1938. During the preceding 20 years his laboratory facilities had constantly improved. In Kiel, where he had been Professor Extraordinarius since 1918, he established a warm and close relationship with Rudolf Höber, one of the most prominent general physiologists in Germany. This association was certainly fruitful for Meyerhof's scientific development. His facilities at Kiel were rather limited, however. In 1924 he moved to the Kaiser-Wilhelm Institut für Biologie in Berlin-Dahlem, where he became head of a division.

Dahlem was at that time one of the greatest scientific centers in the world. A group of extraordinary men was gathered there in the various Kaiser-Wilhelm Institutes. Meyerhof found his old friend Otto Warburg in the Biology Institute. Carl Neuberg was at the Institute of Biochemistry. Among other names of world renown may be mentioned Fritz Haber and his associates Ladenburg, Polanyi, and Freundlich, at the Institute of Physical Chemistry; and Otto Hahn at the Institute of Chemistry. In many of the seminars held at Haber's institute one could frequently find several Nobel prize winners joining in discussion. Dahlem's stimulating atmosphere and the close contact with these outstanding personalities had a profound influence on Otto Meyerhof.

The facilities that Meyerhof had at Dahlem were not yet adequate for the wide scope of his interests. Therefore, in 1929, when he had the opportunity to join a new institute that he himself could design and plan with all the necessary facilities, he accepted an offer to go to Heidelberg. The Heidelberg Institute was one of the finest of its kind and was ideally suited for his varied research activities. Here he again came in contact with his old teacher Krehl, who was director of the Department of Medicine, as well as the administrative head of the institute.

It is not difficult to realize how hard it must have been for Meyerhof to leave his wonderful institute and his staff of excellent and devoted collaborators. He went first to Paris, where he was warmly welcomed and well received. Through the combined efforts of the late Jean Perrin, René Wurmser, and Henri Laugier, he was appointed director of research at the Institut de Biologie Physico-Chimique. With his untiring energy he immediately started to build up his laboratory under rather difficult conditions. Nevertheless, his productivity continued, as several important papers on the oxidation-reduction phase of glycolysis and the properties of the triose phosphates, as well as the demonstration that phosphorylation is necessary for the biological breakdown of carbohydrate in all cells, bear witness. As he expressed it later in a review article, nonphosphorylating glycolysis is nonexistent except in the imagination of a few people.

When the Nazis invaded France, he and his wife, Hedwig, had to flee under most difficult and trying circumstances. They took refuge in the south of France and eventually, with the help of American friends, the Rockefeller Foundation, and the active interest and efforts of A. N. Richards and D. W. Wilson, they managed to reach the United States at the end of 1940. Meyerhof was appointed research professor of physiological chemistry at the School of Medicine of the University of Pennsylvania, a position he held until his death.

Hardship and suffering, of which the Meyerhofs had no small share, failed to undermine his spirit. The laboratory at Philadelphia was not a large one, but he continued to work actively and productively, as shown by the number and importance of his publications during the past few years. More than 50 papers appeared during this period, bringing the total of his publications to about 400. This amazing productivity is all the more remarkable if one considers that his health was undermined by a severe heart attack suffered in 1944 at Woods Hole, where he spent most of his summers following his arrival in this country. Through the devoted care of his wife he was able to surmount his difficulties and to continue his activities with undiminished energy, until a second heart attack led to his death, which came suddenly and without suffering in the midst of creative work and the preparation of various projects for the future.

During the past few years Meyerhof had discovered the mechanism by which hexose disphosphate accumulates during the fermentation of glucose by yeast extracts (Harden-Young reaction). He demonstrated that this was due to the absence of the enzyme adenosine triphosphatase (ATP-ase), which dephosphorylates ATP. On addition of ATP-ase the yeast extracts fermented glucose to alcohol and carbon dioxide in

the same way as living cells. Incidentally, he also succeeded in partially separating muscle ATP-ase from myosin and obtained the enzyme in soluble form. Concentrating his interest on observations made by Axelrod and his collaborators, he demonstrated that a transphosphorylation from substances such as glucose-1-phosphate, phosphocreatine, or acetyl phosphate, to acceptors such as glycerol or sugars, is catalyzed by phosphatases in the absence of ATP. Such transphosphorylation seem to go preferably from higher to lower energy phosphates. His measurements of the equilibrium constants of the hydrolysis and synthesis of phosphate esters and of the conversion of phosphopyruvate and ADP to pyruvate and ATP permitted an accurate calculation of the energy contained in some of these compounds. Quite recently, still intensely interested in the energy content of key metabolic intermediates—so important for an understanding of the mechanisms underlying the biological utilization of metabolic energy—he measured the heat produced on hydrolysis of various compounds, thus rechecking on some of his old measurements and adding new important data to our knowledge in this field.

The impact of Meyerhof's personality and of his work is perhaps best illustrated by the great number of scientists who received inspiration and training in his laboratory. His pupils came from all parts of the world; many of them have not only developed his ideas further, but have opened up new fields of investigation and created, in their turn, schools which have been referred to as the "second Meyerhof generation." An impressive demonstration of his influence was the tribute paid to him by his pupils and friends on his sixty-fifth birthday. He was given a book entitled *Metabolism and Function,* comprising papers by many of this generation's most brilliant scientists in physiology and biochemistry. This was an expression not only of admiration and respect, but also of the ties of affection by which his pupils and colleagues felt bound to one in whom they saw an understanding and devoted friend. Many honors were bestowed upon him by his colleagues and by scientific societies, such as the National Academy of Sciences (U. S.), the Royal Society of London, the Harvey Society, and many others.

At a symposium on phosphorus metabolism held at Johns Hopkins University in June 1951, which, as Bentley Glass pointed out, dealt with virtually every aspect of the chemistry of life, Meyerhof made a masterly introduction, which he closed with the following words: "Just as the role of iron in biological reactions is now made completely understandable by the work of Otto Warburg as being necessary for the catalysis of oxygen transfer, so the role of phosphate compounds in the organisms is made understandable by their importance for energy transfer." It may be added that the work of Otto Meyerhof made this understanding possible.

Meyerhof was one of the greatest thinkers among the biologists of our time. He repeatedly raised the question of the philosophical basis and background of physiology and the relation of life phenomena to physics and chemistry. He staunchly supported the view that the laws of physics and chemistry must be applicable to the forces acting in the living organism. He was convinced that many of the manifestations of life will eventually become understandable in physicochemical terms, and he fought vigorously against vitalistic and neovitalistic views. It is in this light that one must consider Meyerhof's views on Goethe's scientific writings, especially his theory of colors. In a critical essay presented at the Goethe bicentennial celebration of the Rudolf Virchow Society in New York a few years ago, Meyerhof accepted Goethe's contributions in the descriptive field; but when Goethe contradicted the views of Newton, he came in conflict with the laws of physics because his method of approach was not adequate. As Meyerhof emphasized, however, the scientific analysis of nature was not Goethe's real goal. It was the search for the deeper meaning of creation—*"die Ahnung des Ewigen im Endlichen,"* to use the words of Fries. In Meyerhof's basic philosophical attitude, physics and chemistry are only *one* aspect of the world in which we live. Deeply influenced by the transcendental idealism of Kant and Fries, he was constantly aware of other aspects belonging to a category that cannot be analyzed by physicochemical methods. He felt that, in the last analysis, the whole of scientific truth becomes relative to other values which refer no longer to things that may be recognized by our senses, but to what is beyond those things—the meaning of the world.

Meyerhof had a genuine enthusiasm for art, poetry, and literature and a deep interest in archaeology and history. His knowledge in these fields surprised even highly specialized experts. Very few people know that he liked to write poetry. His poems, which are of great intellectual depth and exquisite beauty, reflect a keenly sensitive spirit. His philosophical background, the tremendous range of his knowledge, the remarkable gift of integrating a great variety of phenomena, the originality of his ideas, and the elegance of his methods—all these factors contributed to making his work outstanding and may account for the extraordinarily wide scope of his achievements. The combination of a great scientist and a great man made him a real leader and one of the most distinguished representatives of modern science.

News and Notes

Meeting in Memory of Otto Meyerhof

A MEETING in memory of Otto Meyerhof was held in the auditorium of the University Museum, University of Pennsylvania, on December 6. D. Wright Wilson, professor of physiological chemistry and head of the department with which Dr. Meyerhof was associated, was the chairman of the meeting. Dr. Wilson described how Meyerhof's constant enthusiasm for scientific research had inspired the whole department and the medical students.

A. Newton Richards who, as vice president for medical affairs, was responsible for bringing Meyerhof to the University of Pennsylvania in 1940, described the dramatic events that preceded his escape from Europe. Dr. Richards recalled that the rescue from Nazi-occupied France became possible through the combined efforts of the Rockefeller Foundation, university authorities, and the Emergency Rescue Committee of the Unitarian Service Committee. He gave a succinct but vivid description of the trials through which Meyerhof and his family passed during that period and of the serenity of mind that never forsook him.

Samuel Gurin, of the Department of Physiological Chemistry, speaking on behalf of the department members, emphasized Meyerhof's unremitting work in the laboratory every day and his active concern with each experiment. As Dr. Gurin put it: "There are many standards by which one can estimate greatness, and Otto Meyerhof measured up to all of them."

As representatives of Meyerhof's pupils, his friends and former associates, Severo Ochoa, of New York University, and David Nachmansohn, of Columbia University, gave addresses. Dr. Ochoa outlined the multiform aspects of Meyerhof's brilliant personality, and Dr. Nachmansohn discussed some of Meyerhof's philosophical views and activities. Fritz Lipmann, of Harvard University, another former associate, who was unable to attend, sent a letter describing the strong influence Meyerhof exerted on his pupils.

Among the many letters and telegrams were messages from Otto Warburg, of Berlin, with whom Meyerhof had been closely associated for 40 years; A. V. Hill, of London, one of his closest friends and scientific associates, with whom he shared the Nobel prize in 1923; and H. O. L. Fischer, of Berkeley, California, who was a friend of long standing. Messages from prominent pupils included those from A. von Muralt, Bern; P. Ohlmeyer and H. H. Weber, Tübingen; E. Lundsgaard, Copenhagen; and H. Blaschko, Oxford. There were messages also from his French colleagues C. Fromageot and R. Wurmser, the latter representing the institute where Meyerhof worked in 1938 and 1939. His interest in anthropology was emphasized in an appreciative letter from S. N. Kramer, curator at the University Museum.

The meeting closed with an address by Carl F. Cori, professor of biological chemistry, of Washington University, who outlined Meyerhof's scientific personality and achievements which, in Dr. Cori's words, represent "most of the progress of biochemistry in the last 30 years." Dr. Cori pointed out Meyerhof's universality, which made him outstanding as a scientific leader. A message from Gerty T. Cori, who was unable to attend, was read by Dr. Cori.

D. WRIGHT WILSON
Department of Physiological Chemistry
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Scientists in the News

Ervin G. Bailey and **Linton E. Grinter** have been added to the Committee on Equipment and Supplies of the Department of Defense Research and Development Board. Mr. Bailey, vice president of Babcock & Wilcox Co., became associated with the committee as chairman of its Panel on Mechanical Equipment in 1949. Dr. Grinter, research professor of civil engineering and mechanics at Illinois Institute of Technology, has served the committee since 1949 as chairman of the Panel on Heavy Equipment and Engineering Construction.

Foster S. Brown has been named president of the State University Teachers College at Oswego, N. Y. Dr. Brown is dean of the State University Teachers College at Cortland. He will take office on July 1, succeeding **Harvey M. Rice**, who last year was named president of Teachers College at Buffalo. **Thomas R. Miller**, who has been acting president at Oswego since Dec. 1, will remain as dean. **Edward E. Redcay**, dean of the Teachers College at Plattsburg, has been appointed acting president of the college, succeeding **Charles Ward**, who died on Feb. 27.

Gordon H. Chambers has been elected president of the Foote Mineral Company to succeed **H. C. Meyer**, who has been made chairman of the board. Mr. Chambers joined the company in 1928 and has been executive vice president since early in 1951.

Robert R. Commons, assistant clinical professor of medicine at University of Southern California Medical School, has been elected chairman of the Western Section of the American Federation of Clinical Research.

N. A. Dobrovolskaja-Zavadskaja, professor of biological sciences at the Institute of Radium, Paris, specialist in radiobiological, cancer, and experimental medicine, is planning a trip to the U. S. this fall. I. Rozhin, Detroit Institute of Cancer Research, and M. P. Melnik, Harper Hospital, Detroit, are arranging her schedule of lectures and conferences.

Eugene A. Gillis has been appointed chief of the Health Division of the Technical Cooperation Mission to Beirut. Dr. Gillis, who was chief of the U. S.

Public Health Service's Division of Commissioned Officers, will be in charge of the health program of the TCA Mission working in cooperation with the Ministry of Health of Lebanon.

Elizabeth Graddy has been named home economics leader of the Extension Service of Rutgers University. She had been a home economics demonstration agent in New York and New Jersey. An assistant state leader of home agent work in New York, she was associated with Cornell University.

Donald R. Griffin, associate professor of zoology at Cornell University, has discussed "Sensory Physiology and the Orientation of Animals" as a Sigma Xi national lecturer at 15 Sigma Xi chapters and clubs, and two Resa branches in Maryland, Delaware, the District of Columbia, Virginia, West Virginia, Kentucky, Ohio, Indiana, and Pennsylvania.

E. E. Jones, instructor of microanatomy at the Medical College of Virginia, has been appointed head of the Microscope Slide Department of Ward's Natural Science Establishment, which is celebrating its 90th anniversary this year.

Waldo E. Lessenger, dean of the College of Education of Wayne University, retired as president of the American Association of Colleges for Teacher Education at the recent annual meeting of the organization in Chicago. The new president is **Robert E. McConnell,** of Central Washington College of Education, Ellensburg.

Ralph Linton, Frank H. H. Roberts, Jr., and **Carleton S. Coon** were recipients of Viking Fund Medals and Awards for 1951, presented at the sixth annual Award Dinner of the Wenner-Gren Foundation for Anthropological Research. Ralph Linton, of Yale University, received the Viking Fund Medal in General Anthropology as chosen by the American Anthropological Association; Frank H. H. Roberts, Jr., of the Smithsonian Institution, the Viking Fund Medal in Archeology as chosen by the Society for American Archaeology; and Carleton S. Coon, of the University of Pennsylvania, the Viking Fund Medal in Physical Anthropology as chosen by the American Association of Physical Anthropologists.

Directors of the Consolidated Vultee Aircraft Corporation have elected **Joseph T. McNarney** as president. He succeeds **LaMotte T. Cohu,** who becomes vice chairman of the board. General McNarney succeeded General of the Army Dwight D. Eisenhower in 1945 as commanding general of the United States forces in the European theatre. At the time of his retirement on Jan. 31 he was chief of the Department of Defense Management Committee.

Bruno Minz, maître de recherches at the Laboratory of General Physiology at the Sorbonne, is spending six months as visiting research professor of pharmacology at the University of Illinois College of Medicine in Chicago.

Harry H. Power, University of Texas petroleum engineering professor, as new chairman of the American Institute of Mining and Metallurgical Engineers' Mineral Industries Education Division, will direct the division's attention to the problem of meeting the unprecedented demand for mineral industries engineers and to the better utilization of the nation's mineral supplies. The division's work covers training and research in petroleum, mining, geological, ceramic, geophysical, and metallurgical engineering.

Anthony J. J. Rourke, of San Francisco, has been chosen executive director of the Hospital Council of Greater New York, succeeding **John B. Pastore,** who died on August 18. Dr. Rourke, who is this year's president of the American Hospital Association, has been for many years physician superintendent of Stanford University Hospitals, director of Stanford University Out-Patient Clinics, professor of hospital administration at Stanford University School of Medicine, and lecturer in the School of Public Health at the University of California.

Raymond Siever, associate geologist in the Coal Division of the Illinois State Geological Survey, is the winner of the 1952 President's Award of the American Association of Petroleum Geologists, made annually to the author, under 35 years of age, of the "most significant original contribution to petroleum geology" published in the *Bulletin* of the Association during the previous year. Selected by a national medal award committee headed by former AAPG president Carroll E. Dobbin, U. S. Geological Survey, Denver, the winning paper is entitled "The Mississippian-Pennsylvanian Unconformity in Illinois." Presentation of the award was made at the annual meeting of AAPG at Los Angeles.

Albert F. Smith has been appointed director of the Carothers Research Laboratory of the Textile Fibers Department of the Du Pont Company. **Charles H. Arrington, Jr.,** has been named to succeed Dr. Smith as a research supervisor in the Chemical Department. Dr. Smith has been with Du Pont since 1936, when he joined the company as a chemist.

Joseph T. Wearn, medical dean at Western Reserve, as chairman of the newly formed committee on blood and related problems in the National Research Council's Medical Sciences Division, will be assisted by **John M. Buchanan,** Philadelphia; **John T. Edsall,** Boston; **Rollin D. Hotchkiss,** New York; **Carl V. Moore,** St. Louis; and **Lawrence E. Young,** Rochester. There are subcommittees on sterilization of blood and plasma, clinical investigation, and etiology and pathology. Chairmen, respectively, are **William S. Tillett,** New York; **Maurice J. Hickey,** New York, and **J. L. T. Appleton,** Philadelphia.

Myron E. Wegman, head of the Department of Pediatrics at the Louisiana State University School of Medicine, in New Orleans, has been appointed to the staff of the Pan American Sanitary Bureau, WHO Regional Office. Dr. Wegmann will take charge

of the bureau's newly created Division of Education, Training and Technical Services, a position he will assume June 1, at the end of the academic year.

Education

Cornell University will hold a summer laboratory course in Techniques and Applications of the Electron Microscope in the Department of Engineering Physics. James Hillier, of RCA, and C. E. Hall, of MIT, will be guest lecturers. Benjamin M. Siegel will direct the course, and all inquiries should be addressed to him at Rockefeller Hall, Ithaca, N. Y.

The summer session of the **University of Havana** will extend from July 7 to Aug. 16 and is designed especially for North American teachers and students. Most courses are in Spanish and are open to anyone over 17 who has a high school diploma or its equivalent, with the exception of those who enroll only in language courses or without credit. Full information may be obtained from the secretary of the summer school.

Among the special summer programs offered by **Massachusetts Institute of Technology** are: Infrared Spectroscopy (June 16–27), Richard C. Lord and Foil A. Miller; Elastic High Polymers in Science and Industry (June 16–July 5), Ernst A. Hauser; Instrumental Analysis (Aug. 18–22 and Aug. 25–29), David N. Hume and Lockhard B. Rogers. Application forms and further information may be obtained from Ernest H. Huntress, director of the Summer Session.

Financed by a grant from the Ford Foundation, the **University of Michigan** is investigating participation in community affairs, including political activities, in the Detroit metropolitan area. Ronald Freedman, of the Department of Sociology and the Survey Research Center, who is in charge of the survey, plans to make an annual study of the same area, with the major objectives of making available social science data of value to the community, and providing a basic research facility for the Michigan faculty and an agency for training graduate students.

Polytechnic Institute of Brooklyn will hold its annual series of summer laboratory courses beginning June 2 and extending to Aug. 1. X-ray diffraction, molecular weight and shape of macromolecules in solution, and polymerization and copolymerization techniques will be among the topics covered. Full information will be supplied by I. Fankuchen, head of the Division of Applied Physics.

The Medical Branch of the **University of Texas** is planning to coordinate all teaching in clinical laboratory and radiation technology, physical occupational therapy, medical record librarianship, social service, and hospital administration. These auxiliary medical service curricula will be made available at the beginning of the fall semester. The Medical Branch has recently received a grant from the family of H. H. Weinert, a former regent, to support cardiovascular research under the direction of George Herrmann.

Grants and Fellowships

The Bobst Awards, established by the Bobst Pharmacal Co., Inc., to encourage and stimulate more international research on the problems of aging, will be presented annually for the three best papers submitted by members of the International Association of Gerontology or their associates. The first two awards went to Albert I. Lansing, of Washington University School of Medicine, and J. A. Huet, Hôpital de Nanterre, Paris, for papers presented at the second International Gerontological Congress.

The **Joseph P. Kennedy, Jr. Foundation** has donated $1,250,000 toward the completion of a new home and school for mentally retarded boys in Cook County, Ill. Local citizens will be asked to meet the remaining cost of the $4,000,000 institution, which will be open to all children regardless of race, religion, or ability to pay.

The **Muscular Dystrophy Associations of America** have added three new research grants to the six created within the past year. W. F. H. M. Mommaerts, of Duke; Edmund L. Hove, of Alabama Polytechnic; and Theodore Winnick and Harry M. Hines, of the University of Iowa, are the researchers whose work will be supported.

The **National Science Foundation** has awarded $9500 to Kansas State College for a study of the behavior patterns of certain solitary hymenoptera. The three-year study will be conducted by Howard E. Evans, authority on spider wasps.

The **National Tuberculosis Association** has established the Will Ross Medal, to be awarded annually in memory of the former president of the association, for "outstanding and distinguished contribution to the tuberculosis control movement in some field other than that of medical science." The first award will be made at the annual meeting in Boston May 26.

Because of its interest in marine ecology, especially as it applies to the conservation of marine resources, the **New York Zoological Society,** on the recommendation of the Conservation Foundation, has made a grant for 1952 of $4000 to the Marine Biological Laboratory at Woods Hole to establish a new department of Marine Ecology. The course this year is limited to 12 advanced or graduate students, and will begin on July 31 and continue to Sept. 6. Bostwick H. Ketchum, Woods Hole Oceanographic Institution, will be in charge of the course, and W. C. Allee and Alfred C. Redfield will be consultants.

Assets in the **Van Maanen Fund, Inc.,** founded by Adriaan van Maanen, Mount Wilson astronomer, have been presented to the California Institute of Technology. Interest on the principal, amounting to approximately $15,000, will be used to support a graduate fellowship in astronomy in alternate years, thus serving as a permanent memorial to Dr. van Maanen.

In the Laboratories

Los Alamos Scientific Laboratory has added the following scientists to its staff: Robert B. Day and Rolland A. Missman, Jr., physicists; Francis B. Harrison, mechanical engineer and physicist; Fred J. Liederbach, Jr., and Frank E. Pretzel, mechanical engineers; and Kent L. Newlin and Theodore T. Shull, chemists.

Magnex Corp., 90-28 Van Wyck Expressway, Jamaica, N. Y., has been formed to produce transformers, nuclear instruments, relay mechanisms, and other electronic equipment. Controlling interest is held by Nathan Straus-Duparquet, Inc., and Magnex will also be the production affiliate of Patterson, Moos & Company, New York research and development firm, which is moving to the Jamaica location.

The Board of Directors of the **Glenn L. Martin Company** has elected George M. Bunker president, general manager, and a director, succeeding C. C. Pearson. Most recently, Mr. Bunker was president and general manager of Trailmobile, Inc. J. B. Wharton, Jr., was elected vice president–finance to succeed Richard L. Johnson.

Robert Newell DuPuis has joined **Philip Morris & Co., Ltd., Inc.**, as director of research and development, a recently established post. He has been with S. C. Johnson & Son, Inc., as manager of research and development.

Philips Laboratories has bought Richmond Hill, the former 44-room mansion and 13-acre estate it has occupied as a research laboratory since 1944. Improvements in the buildings will make them more suitable for research and development purposes.

J. T. Sheehy, former manager of the Fernandina and the Grays Harbor divisions of **Rayonier, Inc.**, has been elected vice president. A. N. Parett, formerly in charge of chemical research activities, will become vice president in charge of research and development.

Meetings and Elections

At its annual meeting in December the **American Mathematical Society** chose G. T. Whyburn, of the University of Virginia, as president-elect. He will become president next Jan. 1. Richard Brauer, of the University of Michigan, and Deane Montgomery, of the Institute for Advanced Study, were elected vice presidents, and Einar Hille, of Yale, and P. A. Smith, of Columbia, were elected trustees.

The **Pennsylvania Academy of Science** will hold its 28th annual meeting at Dickinson College, Carlisle, Apr. 10–12. Sections for contributed papers in biology, chemistry, physics, and geology, and botany and geology field trips, have been arranged. There will also be a general session at which invited papers by scientists in industry will be presented.

A Symposium on Cortisone and Compound F—Local Tissue Actions and Possible Mechanisms will be held at the College of Medicine of the University of Cincinnati May 1. Eighteen scientists, mainly from Eastern and Midwestern universities and laboratories, will participate. There will be no fee for the conference, but attendance is limited. Stanley Dorst is dean of the College of Medicine.

West Virginia Academy of Science will hold its 27th annual meeting at West Virginia Wesleyan College, Buckhannon, May 2–3. Gustav A. Swanson, head of the Department of Conservation, Cornell University, will speak on the evening of May 2 on "Trends in Wildlife Conservation."

Miscellaneous

The **American Society of Naturalists** has named the following members to the Editorial Board of the *American Naturalist*: Marston Bates, Th. Dobzhansky, C. L. Hubbs, and David D. Keck. They will serve with the following previously designated members: G. E. Hutchinson, Thomas Park, G. L. Stebbins, Jr., Conway Zirkle, and L. C. Dunn (managing editor).

The Viral and Rickettsial Registry of the **American Type Culture Collection** has been augmented by the addition of six new strains since the original list was published in 1950. They are as follows: "Influenza C" virus; High Point, Ohio-1, Connecticut-5, and Nancy strains of Coxsackie virus; and the Karp strain of the Rickettsia of scrub typhus (*R. tsutsugamushi*). A preparation of the virus of herpes simplex, which was listed but not available when the registry was established, is now on hand. Requests for specimens of these and other agents in the registry should be addressed to 2029 M St., N.W., Washington 6, D. C. They must be authorized by the head of the department in which the request originates. A descriptive list of the 53 virus and Rickettsial strains now available may be had for the asking. A meeting of the committee of contributors and advisers to the registry will be held Apr. 30, in connection with the convention of the Society of American Bacteriologists at Boston, to plan further operations.

A reduction of 77 per cent in the 1953 appropriation for the **National Science Foundation**, from $15,000,000 to $3,500,000, has been recommended by the Committee on Appropriations of the House of Representatives. The amount recommended for the full fiscal year is the same as that appropriated to the foundation last November for the balance of fiscal 1952. In its report on the foundation the House Committee said that it

> . . . is aware of the importance of this activity and the program which it sponsors and it is reluctant to retard development of it. However, it is a new activity which is unlikely to provide assistance to the country in the immediate emergency. The committee feels, therefore, that expansion to the full amount of the authorization ($15,000,000) should be deferred until the financial condition of the Treasury has improved.

Technical Papers

Gastric Mast Cell Diapedesis[1] in the Albino Rat[2]

Perihan Cambel, Cecilia E. Conroy, and James T. Sgouris

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Mast cells have been observed by us in the stomach wall and in the gastric secretion of the albino rat. Twenty-two young adult rats (11 females, 11 males) of the Sprague-Dawley-Holtzman strain were killed by neckstroke, after having been fasted for 36 hr. The stomachs were opened by cutting along the larger curvature. After gently removing food traces, two smears each were taken from the gastric secretion covering the glandular mucosa. One was stained with Wright's stain, the other with a 1% aqueous solution of methylene blue, which is known to stain mast cells metachromatically in fresh, unfixed tissues (*1*).

The stomachs of the rats were cut according to our standard procedure (*2*), fixed in 80% ethanol, and embedded *in vacuo*. Paraffin sections were stained with hematoxylin and eosin, and with 0.5% aqueous solution of toluidine blue 0.

The following results were obtained with all animals. Microscopically, the smears of the gastric juice showed a strikingly rich bacterial flora. Columnar cells, polymorphonuclear leucocytes, and sheets of squamous cells were seen in varying numbers. The amount of mucus also varied. Large mast cells with distinctly metachromatic granules were seen (Fig. 1), varying from 0 to 4/microscopic field, with cellular material. In the cellular debris, free nuclei and disintegrating mast cells showing pseudopods, vacuolation, and various degrees of disintegration were observed.

Metachromatic mast cells were observed in the submucosa of the forestomach and of the glandular stomach in all zones (*2*). They also could be seen lying in the muscle layer and in the subserosa. Their nuclei were usually masked by their granules. Vacuolation of mast cells in varying degrees was noted.

Except for the presence of mast cells in it, the cytological picture of the gastric secretion was similar to that described by Hollander *et al.* (*3*). The presence of leucocytes in the juice supported the observations of Tomenius (*4*) on gastric leucopedesis. No recording of the presence of mast cells in the gastric juice was encountered in the literature (*1, 3–5*). No mast cells were found in the stomach wall or in the gastric secretion of 3 rhesus monkeys and 10 guinea pigs (*6*).

Because the ameboid movement of mast cells (*7, 8*) and gastric leucopedesis (*4*) have been established, the conclusion can be drawn from our findings that gastric mast cell diapedesis occurs in the albino rat. During and at the end of this migration, the mast cells shed a part or all of their metachromatic granu-

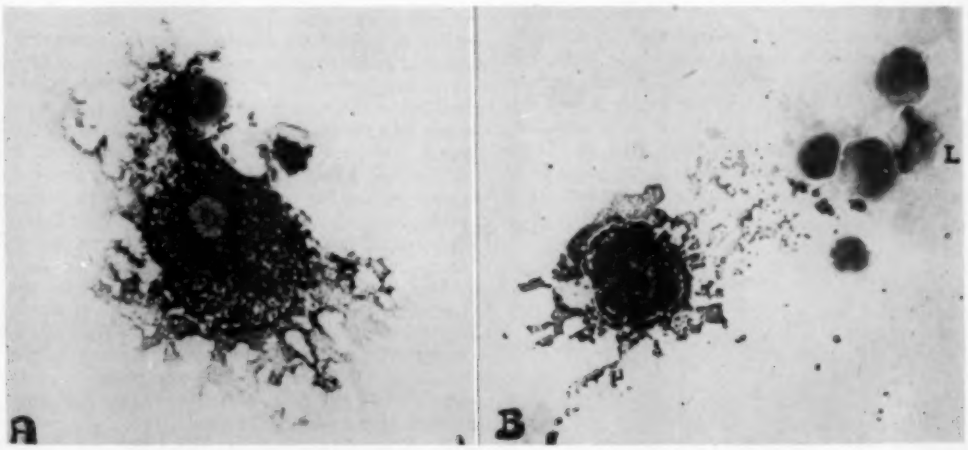

FIG. 1. Mast cells in gastric smear stained with methylene blue. *A*: Mast cell with distinctly metachromatic granules around the nucleus and hazy granules in the peripheral, hazy pseudopods. One of these at the upper pole of the cytoplasm seems to be englobing a cell. *B*: Disintegrating mast cell. *L*: Leucocyte. ×500.

[1] Diapedesis (from the Greek *dia*, 'through'; and *pedesis*, 'a leaping') has been used to describe the passage of blood cells through the unruptured vessel walls into the tissues. Tomenius and previous authors employ "leucopedesis" and "leucocytic diapedesis" to describe the passage of leucocytes through the stomach wall. We felt justified, therefore, in using the expression gastric mast cell diapedesis in referring to mast cell migration through the stomach wall.

[2] This investigation was supported by Cancer Research Grant C-978 from the National Cancer Institute of the National Institutes of Health, U. S. Public Health Service.

lar substance into the tissues or the gastric juice, as evidenced by the extracellular granules and cytoplasmic vacuolation previously described. This supports the point of view of Paff and Bloom (*8*) concerning the secretory life cycle of the mast cell.

References

1. Janes, J., and McDonald, J. R. *Arch. Path.*, **45**, 622 (1948).
2. Cambel, P., and Sgouris, J. *Stain Technol.*, **26**, 243 (1951).
3. Hollander, F., Stein, J., and Lauber, F. E. *Gastroenterology*, **6**, 576 (1946).
4. Tomenius, J. H. *Acta Med. Scand.*, Suppl. 189, 11 (1947).
5. Swarts, J. M., *et al. Gastroenterology*, **14**, 265 (1950).
6. Cambel, P. Unpublished results.
7. Hirt, A. *Klin. Wo-chschr.*, **17**, 1599 (1938).
8. Paff, G. H., and Bloom, F. *Anat. Record*, **104**, 45 (1949).

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A New Brain Slicing Technique for Tissue Respiration Studies

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The problem of preparing brain slices for respiration studies quickly and accurately, with a minimum of damage to the tissues, has never been adequately solved. Brain tissue lacks firm consistency and homogeneity and is therefore subject to more maceration and damage when using free-hand methods of cutting than are some of the other tissues of the body. This problem is magnified in the small animal, such as the mouse or the rat, where the organ is not only gelatinous but is also small. Under these conditions Umbreit (*1*) has recognized that "the free hand method of slicing even by experts leaves much to be desired." In the course of work requiring serial sections of mouse brain tissue for respiration studies using the conventional Warburg respirometer, the senior writer has developed a new technique, rapid and consistent in results, which does not require any prolonged training in manipulation. Further, there is minimal damage to the cut surfaces of the tissue, since no pressure is exerted in cutting, and the tissue is not subjected to the wiping action of a wide blade. In general, the procedure consists of embedding the brain in agar and cutting it with a thin, flat nichrome wire knife, mounted on a microtome developed for this technique.[1]

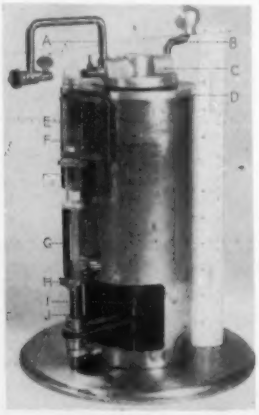

FIG. 1. Microtome with a partially cut embedded brain: *A*, blade frame; *B*, handle; *C*, head; *D*, cylinder cap; *E*, syringe; *F*, mounting block; *G*, brass frame; *H*, split block; *I*, drive shaft; *J*, helical gear; *K*, rubber drive belt.

The microtome (Fig. 1) is mounted on a steel cylinder frame 25.5 cm high having a diameter of 19 cm, which is permanently fixed to a flat, wide base for stability. A shaft 12 mm thick, fixed to the head holding the blade frame and handle, passes through the cylinder cap and ends in a centered well in the bottom plate. The blade rotates on a horizontal fixed plane passing through the embedded tissue, which moves upward a constant distance with each sweep of the knife. The tissue is held in a 10-cc syringe barrel cut off about 2 cm from the tip. The mechanism actuating the plunger of the syringe is a helical gear, connected to the center shaft by a rubber belt, which raises the tissue as the knife is rotated. The instrument described is fixed to cut the tissue 400 μ thick,[2] but any thickness of tissue may be cut by altering the diameter of the drive shaft or helical gear. This may be done with pulleys of various sizes or with a cone-type drive shaft. The syringe barrel holder is a 5×9 cm block of bakelite permanently attached to the cylinder wall and cut vertically in the center to accommodate the syringe barrel snugly when attached to the block with two rubber bands. A groove is cut into the block to accommodate the rim of the barrel. This prevents vertical displacement of the syringe and allows the knife to pass just over the surface of the barrel. The plunger rests on a brass frame riding on each side of the helical gear fixed at the top and bottom to the cylinder frame. A split block, forming the bottom of the brass frame, is grooved to fit the gear and rides upward as the gear is rotated. The plunger may be adjusted as may be required for the tissue, or to return the frame to the bottom after cutting, by opening the screw lock on the frame block, causing the two parts to spring apart slightly and drop. After setting it to the proper depth it may again be tightened.

The U-shaped blade frame (5×8 cm) is patterned after a jeweler's saw. Flat jaws for holding the blade are tightened by thumbscrews, and tension may be exerted on the blade by adjusting the screw passing through the outer part of the frame. The knife blade itself is made from a 0.005″× 0.030″ nichrome heating element wire sharpened on the leading edge with a small stone and Turkish emery. It is not nec-

[1] The authors wish to acknowledge the capable technical assistance of William Marshall in the construction of the microtome.

[2] The measurements were made on the fixed preparations with an eyepiece micrometer.

essary to have as keen an edge as is required for paraffin sectioning. The photomicrograph (Fig. 2)

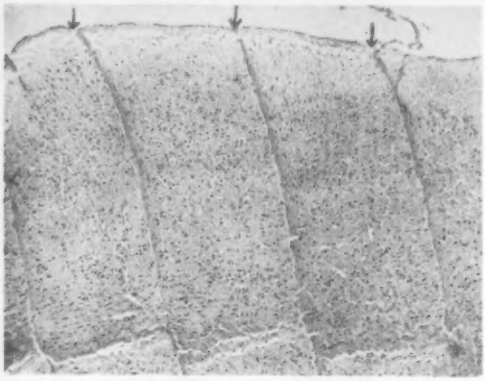

FIG. 2. Formalin-fixed block of sliced brain tissue, cut (7 μ) at right angles to slices (400 μ). Stained with hemotoxylin and eosin. Margins of slices are indicated by arrows.

shows a formalin-fixed preparation stained with hemotoxylin and eosin and cut at approximately right angles to the slices to show the edges of the sliced tissue. A study[3] of these sections showed that tearing and distortion of the tissue were minimal. The cut surfaces appear to be more a separation of the components of the brain on a plane than a sharp cut. The integrity of the cell structures along the line separating the slices appears to be preserved.

Preliminary preparations for embedding the brain consist in melting agar in a water bath, then transferring it to a constant temperature bath held at 39° C. For convenience in handling, a number of test tubes of agar may be prepared beforehand and kept stoppered until used. A large beaker of crushed ice for precooling a small, thin glass vial (2×8 cm) to receive the excised brain and the syringe and plunger is also prepared. A watch glass containing about 5 ml of the same solution to be used in the respirator flask is used to separate the slices transferred from the microtome in preparation for weighing and transferring the slices to the flasks. This is supported by a small beaker or shallow dish containing ice.

The actual procedure begins with the removal and transfer of the brain to the precooled vial in the ice bath, where it is left for about 1 min. The brain is then teased into the well formed by dropping the plunger about 2 cm from the top edge of the syringe barrel. This space is filled to the brim with the agar, and the brain oriented to the desired position, which will be maintained if the syringe is precooled and the agar held at 39°–40° C. The syringe, with a glass vial slipped over the tip to hold the agar in place, is then returned to the ice bath for about 30 sec, mounted on the microtome and the embedded brain cut by rotating the knife. It is important that the sections of cut tissue are not removed until the desired number of slices is obtained or the whole brain sectioned. This stacking of cut tissue helps keep the surrounding agar firmly around the tissues and prevents the slices from being peeled off and torn, as happens when the slices are removed one at a time as cut. Sagittal sections of a whole mouse brain may be cut in less than 10 sec. The entire stack is transferred to the precooled watch glass containing the tissue media. The slices are separated from each other and from the encircling rings of agar by gentle agitation of the solution and some teasing. The selected slices are then weighed and placed in the flasks in the usual manner.

The technique described here offers the advantage of rapidly preparing consecutive brain slices of constant thickness for tissue respiration studies. Further work to adapt this procedure to other tissues is now in progress and will be reported later.

[3] The authors are indebted to Fae Tichy, of the Neuropathology Department of this university, for her valuable assistance in evaluating this important phase of the technique.

Reference

1. UMBREIT, W. W., BURRIS, R. H., and STAUFFER, J. F. *Manometric Techniques and Tissue Metabolism.* Minneapolis: Burgess (1949).

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Production of a Solid Rhenide

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The existence of uninegative rhenium in aqueous solution has been definitely established (*1–3*). Up to the present time the only method that has been successfully employed for the production of rhenide has involved the reduction of perrhenate in acid solution either by means of a Jones reductor or cathodically. A maximum concentration of approximately 0.001 *M* perrhenate has been quantitatively reduced to uninegative rhenium in acid solution (*4, 5*), and a rhenide concentration of 0.0026 *M* has been obtained in an acid solution containing pyridinium chloride (*5*).

We have successfully produced for the first time a solid rhenide material in admixture with potassium hydroxide by reduction of potassium perrhenate in ethylenediamine-water solutions by means of potassium metal. The reaction is carried out in a closed system under nitrogen atmosphere. The valence number of rhenium in the white solid was established in the following way: An aqueous solution of the solid was prepared, and separate aliquot parts were analyzed for rhenium content and for reducing power in terms of number of equivalents of standard oxidizing agent (potassium dichromate) required to oxidize the rhenium to the perrhenate state. Typical values of the valence number of rhenium in the solid established in this manner were: −0.97, −1.06, −1.00, −0.95, −1.16, −0.81.

[1] The authors wish to acknowledge the support of the Office of Naval Research in this investigation.

The optimum conditions for conversion of the perrhenate to solid rhenide are as follows:

1) Composition of solvent, 9.8 g. of water/100 ml ethylenediamine-water solution.
2) Initial concentration of potassium perrhenate, 3 mM/l.
3) Potassium requirement, 4 g/100 ml solution.
4) Initial temperature, room temperature. (The solution warms up to about 60° C in the course of the reaction.)

Under the conditions described above, a conversion of approximately 55% of the initial perrhenate to solid rhenide is obtained. The filtrate contains unreduced perrhenate but practically no rhenide.

An interesting reaction of the rhenide ion has been observed. Treatment of an aqueous solution of the solid mixture of potassium hydroxide and rhenide compound with thallous nitrate solution yields first a white precipitate, presumably thallous rhenide, which rapidly undergoes reaction to yield finely divided thallium metal and the perrhenate ion.

Work is in progress with view of separating the rhenide compound from the potassium hydroxide impurity in order to determine the composition and structure of the former. A full account of our studies will be reported at a later date.

References

1. Lundell, G. E. F., and Knowles, H. B. *J. Research Natl. Bur. Standards*, **18**, 629 (1937).
2. Tomiček, O., and Tomiček, F. *Collection Czech. Chem. Commun.*, **11**, 626 (1939).
3. Lingane, J. J. *J. Am. Chem. Soc.*, **64**, 1001, 2182 (1942).
4. Maun, E. K., and Davidson, N. *Ibid.*, **72**, 3509 (1950).
5. Rulfs, C. L., and Elving, P. J. *Ibid.*, **73**, 3287 (1951).

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Comparative Biological Activity of α-Lipoic Acid and Protogen in the Growth of *Tetrahymena*

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Preliminary experiments in this laboratory indicate that α-lipoic acid can replace protogen completely in the growth of *Tetrahymena*. Snell *et al.* in 1937 (*1*) first demonstrated that acetate was stimulatory in the growth of lactic acid bacteria, and Guirard in 1946 (*2*) reported the occurrence of an acetate-replacing factor(s) in some biological materials. Snell and Broquist in 1949 (*3*) indicated that protogen, the pyruvate oxidation factor, and the acetate-replacing factor for *L. caseii* were either identical or closely related substances. Stokstad *et al.* (*4*) stated that more than one form of this material occurs naturally. Getzendaner (*5*) and Reed (*6*) have concentrated this factor, and Reed *et al.* (*7*) this year reported the preparation of a crystalline compound from liver which was able to replace acetate in the growth of certain lactic acid bacteria and which was required for the oxidative decarboxylation of pyruvate by these organisms. They have named this compound α-lipoic acid and state that its melting range is 47.5°–48.5° C. Kidder's group in 1950 (*8*) stated that one of the functions of protogen in *Tetrahymena* is concerned with the production of acetate.

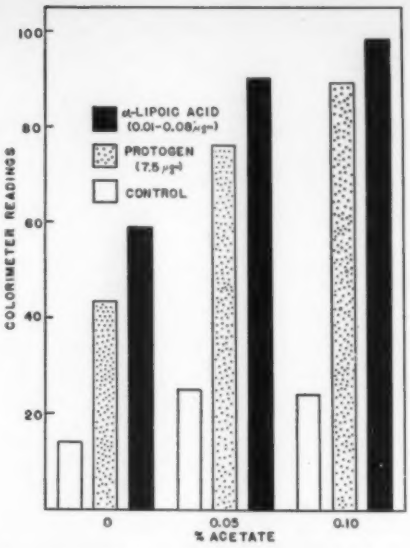

FIG. 1. Comparative effects of protogen and α-lipoic acid on maximum growth of *Tetrahymena*.

Protogen[2] and α-lipoic acid[3] have been compared for their growth effects and also for their ability to spare and replace acetate in *Tetrahymena geleii* (strain E). The protogen crude concentrate used had a value of 7.5 γ/unit, the concentrations of which ranged from 0.125 to 1.0 unit/ml. The α-lipoic acid was tested in concentrations of 0.01–0.08 γ/ml. Other concentrations of this material were not used because of limited availability.

The general methods employed were those of Slater (*9*). The temperature was 25° C, and the initial pH was set at 7.4. Initial inoculation was of the order of 1000 animals/tube. Tests were made in duplicate, and the entire series was repeated. The medium used was that recommended by Elliott (*10, 11*), with the exception that choline and biotin were omitted. Guanylic acid, adenylic acid, cytidylic acid, and uracil were used in 25 γ/ml quantities instead of yeast nucleic acid as recently advised by Elliott (*12*). Growth was measured turbidimetrically, and counts were made of final peak populations.

Purified α-lipoic acid was able to replace protogen

[1] Postdoctoral fellow in the biological sciences, United States Atomic Energy Commission.

[2] The aid of E. L. R. Stokstad, of the Lederle Laboratories Division, American Cyanamid Company, in supplying the protogen is gratefully acknowledged.

[3] The author is indebted to Lester J. Reed, of the University of Texas, for the α-lipoic acid.

TABLE 1

COMPARATIVE ACTIVITY OF α-LIPOIC ACID AND PROTOGEN IN THE GROWTH OF *Tetrahymena geleii* E.

Acetate (%)	Protogen (unit/ml)	Count at 120 hr	Final pH
	1	83,200 ± 12,640*	6.9
	0.5		3.9
0	.25		3.8
	.125		3.5
	0.000		3.4
	1	83,200 ± 5,880	7.3
	0.5		7.2
0.05	.25		6.3, 4.5†
	.125		4.1‡
	0.000		5.3
	1	97,200 ± 14,520	7.5
	0.5		7.5
0.10	.25		7.2
	.125	47,440 ± 1,988	6.2
	0.000		6.0
	α-Lipoic (γ/ml)		
	0.08	95,000 ± 13,520	7.1
	.04		7.4
0	.02		7.4
	0.01	114,800 ± 16,840	7.2
	0.08	111,600 ± 11,880	7.5
	.04		7.5
0.05	.02		7.5
	0.01	131,200 ± 11,200	7.4
	0.08	114,000 ± 8,690	7.6
	.04		7.7
0.10	.02		7.5
	0.01	127,200 ± 10,320	7.6

* This count represents both live and dead animals, since many of the cultures had begun to die here after 72 hr.

† Approximately one half of the cultures had precipitated after 96 hr. Tubes containing the precipitate exhibited the lower pH.

‡ All these cultures had precipitated after 96 hr. Upon microscopic examination, the precipitate was found to consist only of dead cells.

completely in the growth of *Tetrahymena* (Fig. 1). In concentrations ranging from 0.01 to 0.08 γ/ml, α-lipoic acid is more active than protogen in acetate-replacing properties. As noted by Kidder *et al.* (*8*), protogen is active in sparing acetate. Low levels of protogen (0.125–0.5 unit/ml) resulted in considerable acid production in media containing 0–0.05% acetate. Lower population densities were also obtained (Table 1). Concentrations of protogen at 10 units/ml were found by the author (*9*) to be slightly inhibitory in media with 0.1% acetate. Maximal growth (approx 120,000 animals/ml) was obtained by the use of α-lipoic acid in media containing 0.05–0.1% acetate. Considerably lower population densities (approx 80,000 animals/ml) resulted from the use of protogen at the 0.05% acetate level.[4]

[4] Since this paper has gone to press, it has been found that half-maximal growth can be obtained by means of 0.0005 μ of α-lipoic acid.

References

1. SNELL, E. E., TATUM, E. L., and PETERSON, W. H. *J. Bact.*, **33**, 207 (1937).
2. GUIRARD, B. M., SNELL, E. E., and WILLIAMS, R. J. *Arch. Biochem.*, **9**, 381 (1946).
3. SNELL, E. E., and BROQUIST, H. P. *Ibid.*, **23**, 326 (1949).
4. STOKSTAD, E. L. R., *et al. Ibid.*, **20**, 75 (1949).
5. GETZENDANER, M. E. The Concentration of an Acetate-replacing Factor. Thesis, Univ. Texas (1949).
6. REED, L. J. Personal communication (1950).
7. REED, L. J., *et al. Science*, **114**, 93 (1951).
8. KIDDER, G. W., DEWEY, V. C., and PARKS, R. E. *Arch. Biochem.*, **27**, 463 (1950).
9. SLATER, J. V. Growth in *Tetrahymena* in Relation to Carbohydrate Metabolism. Thesis, Univ. Mich. (1951).
10. ELLIOTT, A. M. *Physiol. Zoöl.*, **22**, 338 (1949).
11. ———. *Ibid.*, **23**, 85 (1950).
12. ———. Personal communication.

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The Effects of Cortisone and Heparin on Eosinophils in Defibrinated Human Blood [1,2]

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Four hours after injection of corticotropin (ACTH) into healthy individuals the blood eosinophil count is found to be significantly reduced from pre-injection levels. This adrenocortical eosinopenia also develops in man after treatment with 17-hydroxycorticosterone (Compound F), corticosterone (Compound B), and cortisone, but the latter steroid does not have as striking an eosinopenic effect as the other hormones. During the past 3 years we have tried to reproduce adrenocortical eosinopenia *in vitro* by incubation of human blood with cortisone. Baldridge *et al.* (*1*) and other investigators have also tried to do this, but without success. Both Baldridge and ourselves used heparin as an anticoagulant for blood samples.

Recently we incubated, under sterile conditions, defibrinated blood from 15 patients ill with various diseases associated with eosinophilia. They included patients ill with asthma, polyarteritis nodosa, and other diseases. Incubation of their blood for 4 hr at 37.5° C, alone, with saline, or with nonsteroidal microcrystals (e.g., sulfonamides), had only slight effects on the level of eosinophils in the sample. On the other hand, when a commercial microcrystalline suspension of cortisone acetate or pure crystalline cortisone acetate (1 mg/3 ml blood) was mixed with the defibrinated blood, the absolute eosinophil counts were significantly reduced after 4 hr incubation. This effect of cortisone on the eosinophil count could be blocked by adding heparin (40 u) to the defibrinated blood before introducing the cortisone. The data from our experiments are shown in Table 1. In some experiments with Compound F we have found that it can also produce significant eosinopenia when incubated with defibrinated blood.

[1] Supported in part by a grant from Armour and Co., Chicago, Ill.

[2] We wish to thank Elmer Alpert, of Merck & Co., Inc., Rahway, N. J., for supplying the pure cortisone acetate, and Curtiss E. Meyer, of the Upjohn Company, Kalamazoo, Mich., for supplying the Compound F used in this study.

The technique of counting eosinophils used in our laboratory and the statistical treatment of the data obtained have been described in detail elsewhere (*2–5*). In the investigation reported here each absolute eosinophil count was obtained by counting cells taken up into 2 standard leucocyte pipettes and delivered into 4 double Levy counting chambers. The data obtained were highly significant for each of the bloods studied, as well as for difference of means, P being less than 0.001.

TABLE 1

EFFECT OF INCUBATING DEFIBRINATED HUMAN BLOOD*

Statistical data	Fall of absolute eosinophil counts in defibrinated human blood after 4 hr incubation (%)		
	Saline	Cortisone acetate	Heparin plus cortisone acetate
Mean	15.2	44.9	11.4
S. E.	4.4	3.6	2.7
Fiducial limits ($P = 0.05$)	5.1–25.3	37.2–52.6	5.5–17.3
Mean $\pm \sigma$	1.9–28.5	30.8–59.0	2.1–20.7

* Blood from 15 patients with eosinophilia (490–3000 cells/mm³) was incubated for 4 hr at 37.5° C. Percentage fall is in absolute eosinophil counts from zero time, when saline, cortisone acetate, or heparin, followed by cortisone acetate, was added to the blood.

Thrombosis is a common complication of therapy with ACTH and cortisone acetate (*6,7*), and it also develops after surgical procedures, when adrenal hyperactivity, eosinopenia (*8*), and reduced blood heparin tolerances (*9*) are found. Therefore, on the basis of our findings, it is tempting to speculate that in man adrenocortical hormones interact with heparin as they do with other polysaccharides, such as joint hyaluronic acid (*10*). However, the concentrations of cortisone and heparin used in the *in vitro* investigations reported here were very much larger than obtain in clinical practice.

The morphological changes in the eosinophils which appear after *in vitro* incubation with cortisone, and the effects of combining heparin and adrenal steroid therapy in man, will be reported elsewhere.

References

1. BALDRIDGE, G. D., *et al. Arch. Path.*, **51**, 593 (1951).
2. RANDOLPH, T. G. *J. Allergy*, **15**, 89 (1944).
3. HENNEMAN, P. H., and WESTENHAVEN, M. H. *J. Lab. Clin. Med.*, **34**, 1017 (1949).
4. BEST, W. R., and SAMTER, M. *Blood*, **6**, 61 (1951).
5. BEST, W. R., MUEHRCKE, R. C., and KARK, R. M. *Proc. Central Soc. Clin. Research*, **24**, 14 (1951).
6. COSGRIFF, S. W., DIEFENBACH, A. F., and VOGT, W., JR. *Am. J. Med.*, **9**, 752 (1950).
7. SMITH, R. W., *et al. Science*, **112**, 295 (1950).
8. ROCHE, M., THORN, G. W., and HILLS, A. G. *New Engl. J. Med.*, **242**, 307 (1950).
9. WAUGH, T. R., and RUDDICK, D. W. *Can. Med. Assoc. J.*, **51**, 11 (1944).
10. DUFF, I. F., ROBINSON, W. D., and SMITH, E. M. *Proc. Central Soc. Clin. Research*, **24**, 29 (1951).

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An Implantor for Forming and Accurate Placing of Small Pellets

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Previously reported techniques for implanting solids into animals (*1–3*) were for large, preformed pellets. In the course of experiments requiring accurate placing of a known small amount of compact, sterile solid, an instrument was designed and constructed which fulfilled these requirements.

The device (Fig. 1), made entirely of stainless steel,

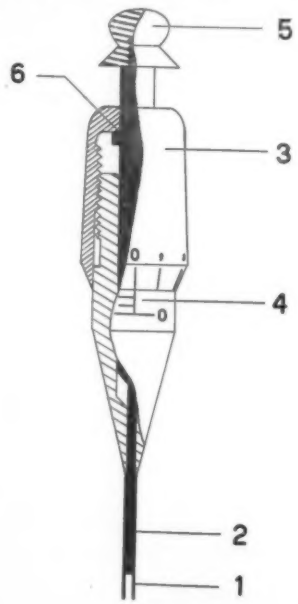

FIG. 1.

consists of a thin-walled tube (1), with a close-fitting plunger (2). When preparing a pellet of material for implantation, the plunger is set to the desired length by turning the body (3) to the setting on scale (4). The plunger head (5) is withdrawn to collar check (6). The body of the device is held firmly, and the tube tamped into a small dish containing the substance (fine crystals or powder) to be used for study.

A sharp needle approximately the size of the pellet is used to make an entry for the tip of the instrument, after which the solid which has been compacted in the end of the tube is ejected *in situ*. Sterile precautions in preparation of the pellets consisted of using sterilized glassware and implantor, with care to avoid contamination, and were sufficient to avoid infecting experimental animals.

The number of taps required for compacting a

pellet of satisfactory hardness depends on the length of the pellet, the diameter of the tube, and the material.

Calibration data are presented for two implantors of each size (Table 1); pellets made of cholesterol were weighed individually on a microbalance.

TABLE 1

Implantor		Pellet length (mm)	Tampings (No.)	Sample size (n)	Mean wt (mg)	S.D.
No.	Diam (mm)					
1	0.85	1.0	10	10	0.534	± 0.03
		2.0	20	30	0.984	± .05
2	0.835	1.0	10	10	0.520	± .02
		2.0	20	20	0.877	± .06
1	2.505	1.0	10	10	4.896	± .4
		2.0	20	10	8.345	± .26
		3.0	25	10	12.585	± .5
2	2.48	1.0	10	10	4.483	± .4
		2.0	20	10	8.705	± .5
		3.0	25	10	12.117	± 0.4

By tapering the tube end to a cutting edge, the device can be used as a punch and implantor for thin slices of sterile tissue.

References

1. Shelesnyak, M. C., and Engle, E. T. *Anat. Record*, **53**, 243 (1932).
2. Shear, M. J. *Am. J. Cancer*, **26**, 332 (1936).
3. Deanesly, R., and Parkes, A. S. *Proc. Roy. Soc. (London)*, B, **124**, 279 (1937).

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Bactericidal Effects of Propylene and Triethylene Glycol Vapors on Airborne *Escherichia coli*[1]

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In 1941 it was initially reported from this laboratory that the vapors of certain glycols had marked bactericidal effects upon airborne microorganisms (*1, 2*), and these reports were shortly followed by others describing the phenomenon in more detail (*3–9*). In these early reports it was stated that the killing of airborne bacteria was most rapid in the presence of concentrations of either propylene or triethylene glycol vapor that most nearly approached the saturation levels for these substances in the air and that at concentrations below this range the bactericidal effects were less apparent. Furthermore, it was noted that the lethal action of glycol vapors was less marked at relative humidities above 70%. A wide variety of microorganisms, dispersed into the air from broth cultures, was found to be susceptible to the germicidal activity of the glycol vapors. Included among these were *Staphylococcus albus* and *aureus*; *Streptococcus hemolyticus*, Groups A and C; *Str. viridans*; Types I and III pneumococci; *Bacillus subtilis*; *Hemophilus influenzae* and *pertussis*; Friedlander's bacillus; and *Escherichia coli*. Subsequent investigations reported from this laboratory dealing with the mechanism (*10*), rate of bactericidal action of glycol vapors (*11*), and the effects of desiccation (*12*) have utilized Group C hemolytic streptococci, pneumococci, and staphylococci because these organisms were considered to be more typically representative of the respiratory pathogens. From this work has arisen a better understanding of the paramount significance of relative humidity and glycol vapor concentration in determining the bactericidal efficacy of these compounds in the air.

Independent investigators have reported data confirming the susceptibility of some of the previously listed organisms to the glycol vapors (*13*) and, in addition, have found that *Serratia marcescens* and *Salmonella pullorum* (*14*), *Penicillium notatum* (*15*), and tubercle bacilli (*16*) were killed when atomized into saturated atmospheres of these substances. In no instances were airborne vegetative microorganisms, atomized from broth cultures, found to be resistant to the germicidal action of the glycol vapors.

A recent report by Nagy and Mouromseff (*17*) has questioned the validity of these data and thrown doubt upon the lethal effect of propylene and triethylene glycol vapor upon airborne *E. coli*. Using this organism atomized from broth cultures into air containing unmeasured concentrations of either propylene or triethylene glycol, they were unable to demonstrate any bactericidal activity. From their data these authors concluded that the primary effect of the glycol vapors was to increase the sedimentation velocity of the airborne bacterial particles by condensing upon them and hence mechanically removing them from the air. Furthermore, they suggested that the organisms in the sedimented bacterial particles were not necessarily killed but, following evaporation of the condensed glycol, might be redispersed into the air and again be capable of initiating infection. Because their conclusions are so widely at variance with those of other workers in the field, as well as with our own, we considered it essential to report our data, which we believe demonstrate that, under the prescribed physical conditions, propylene and triethylene glycol vapors in adequate concentrations in the air are bactericidal for *E. coli* atomized from liquid cultures, as they are for other microorganisms.

The experiments included in this report were done in the 640-cu ft chamber which has been previously described in detail (*18*). A 17-in. fan, rotating at 500 rpm, was centrally located on the floor and the air stream directed against the ceiling, thus providing adequate turbulence for uniform mixing of the chamber air. Temperature and humidity were pre-

[1] This investigation was supported (in part) by a research grant from the National Institutes of Health, U. S. Public Health Service, and the Douglas Smith Foundation, University of Chicago.

[2] With the technical assistance of Mabel Smith.

cisely controlled, and the values were checked at the start and finish of each experimental run. All experiments were done at 70°–73° F.

The centrifugated sediments of young actively growing cultures of *E. coli* were resuspended in sterile heart infusion broth to make a fivefold concentration of the original cultures. This bacterial suspension containing 1.5×10^9 microorganisms/ml was dispersed from a Graeser atomizer placed above the fan and operated for 30 sec at a pressure of 100 mm Hg, utilizing dry air which had been passed through an activated alumina drying tower (Lectrodryer). The weight of the suspension atomized was 0.35 ± 0.01 g for the experiments reported, and the resulting bacterial aerosol had a bacterial median diameter of 1.5 μ (*19*).[3]

Following the completion of the control run, the humidity was adjusted to the desired level, and the triethylene glycol vaporizer set on the floor immediately below the circulating fan. Vaporization, accomplished by means of a 60-w light bulb immersed in a beaker of glycol placed inside a brass cylinder open at the top, was continued for several hours until a dense Tyndall beam was demonstrable. Air samples, taken at the beginning and end of each test experiment, were analyzed for triethylene glycol content by the method of Kaye (*20*). Concentrations ranging from 10 to 25 μg/l of air were found (equivalent to 2–10 times saturation). At the conclusion of each test the chamber was thoroughly washed and aired. Air analyses confirmed the absence of measurable concentrations of triethlyene glycol in the chamber during the control experiments.

Propylene glycol was vaporized from a beaker which was filled with three times the quantity of glycol calculated to saturate the air of the chamber and then was placed upon an electrically operated hot plate. Vaporization was continued for about 30 min until the maximum Tyndall effect was noted, and then the test experiment was begun. Analytical determinations of the propylene glycol content of the chamber air taken during the test experiments and done according to the technique of Puck and Wise (*21*) revealed concentrations ranging from 0.2 to 0.4 mg of propylene glycol per liter of air (equivalent to 1–2 times saturation). At the conclusion of the experiment the chamber was thoroughly washed and ventilated, and analyses taken during the control experiments confirmed the absence of measurable concentrations of propylene glycol in the chamber air.

Two methods of bacterial sampling were used, one of which, the Folin-bubbler sampler (*22*), was most effective for fine bacterial particles (less than 5 μ in diam), and the other, consisting of 3% agar settling plates, was selective for larger particles. By the use of two such diverse methods of bacterial sampling it was felt that it would be possible to follow quantitatively the behavior of the fine bacterial particles capable of long airborne carriage, as well as the sedimentation of the larger droplets that were present in the air for relatively short periods of time following atomization. The bubbler samplers were operated at a flow of 1 cu ft air/min according to the schedule shown in Tables 1 and 2. Appropriate aliquots were then taken from the bubbler samplers and plated in 3% agar, incubated for 18 hr, and the colonies counted. From this data it was possible to calculate the number of viable organisms per cu ft of air recovered by the sampler.

The open settling plates were exposed for 5-min periods at the same time and on the same schedule as was used for the bubbler samplers and shown again in Tables 1 and 2. Following exposure the settling plates were incubated for 18 hr, and the resultant colonies counted.

The data presented in Tables 1 and 2 are typical of the results obtained when *E. coli* was atomized from liquid cultures into saturated atmospheres of either propylene or triethylene glycol vapor at various relative humidities. These particular experiments were selected from many similar ones for illustrative purposes. They demonstrate the marked dependence of the bactericidal action of the glycol vapors upon the relative humidity, with decreasing rates of kill occurring as the humidities were raised above 50%. By plotting the numbers of survivors logarithmically

TABLE 1

EFFECT OF PROPYLENE GLYCOL VAPOR UPON AIRBORNE *E. coli* AT 72° F

Sampling (time interval from beginning of spray in min)	No. of viable organisms recovered			
	Control (no glycol)		Test (glycol 11.0 mg/ft³)	
	Bubbler No./ft³ of air	Settling plate	Bubbler No./ft³ of air	Settling plate
A, Relative humidity = 70%				
0– 5	4180	459	28	211
1– 6	4120	499	12	147
2– 7	3720	427	16	80
3– 8	3300	443	4	36
4– 9	2540	284	3	21
6–11	1900	262	0.8	6
10–15	2840	246	0.8	0
15–20	2160	240	0	0
	K_B* = 0.025	K_{SP}† = 0.025	K_B = 0.27	K_{SP} = 0.29
B, Relative humidity = 50%				
	Control (no glycol)		Test (glycol 14.7 mg/ft³)	
0– 5	2440	223	0	7
1– 6	3640	192	0	1
2– 7	1760	164	0	0
3– 8	1800	148	0	0
4– 9	2100	133	0	0
6–11	1680	131	0	0
10–15	1520	89	0	0
15–20	1140	70	0	0
	K_B = 0.022	K_{SP} = 0.029	K_B = ∞	K_{SP} = 1.71

* $K_B = K_{\text{Bubbler}}$.
† $K_{SP} = K_{\text{Settling plate}}$.

[3] This value indicates that 50% of the viable bacteria were contained in particles of less than 1.5 μ.

as a function of time, the data for both the bubbler samplers and the settling plates fell on a straight line. Using the slopes of these lines as indices of the rates of kill, die-away constants were obtained which permitted comparison between experiments and were designated K values.[4]

The analytical values given for the amount of glycol present in the air are greater than the calculated quantities necessary to saturate the atmosphere with vapor because the analytical procedures employed sampled droplets of glycol as well as vapor. These droplets of glycol serve as excellent sources for glycol vapor to compensate for the loss of vapor due to condensation on the walls and floor (*23*) of the experimental room. Thus the maintenance of 100% saturation of the air by glycol vapors is assured for the duration of the experiment.

Only a few seconds are required for the glycol vapor to condense on the bacteria-containing particle and for this droplet to reach equilibrium with the atmosphere in which it is suspended (*10*). The amount of glycol vapor condensing on the particle will be determined by the relative humidity and the degree of saturation of the air by the vapor. In the light of these considerations it can be seen that, under the proper conditions, the effects of the glycols should become immediately apparent. Two possible effects might be conceived: the disappearance of viable cells due to a true bactericidal action comparable to that observed for the action of glycols *in vitro* (*24*) or by the sedimentation of the bacteria-containing droplets resulting from the gain in mass caused by the condensation of glycol vapor upon the airborne particles (*17*). Both effects will be dependent upon the relative humidity and the percentage saturation of the atmosphere but to a different order of magnitude.

TABLE 2

EFFECT OF TRIETHYLENE GLYCOL VAPOR UPON AIRBORNE *E. coli* AT 72° F

Sampling (time interval from beginning of spray in min)	No. of viable organisms recovered			
	Control (no glycol)		Test (glycol 14.7 γ/l)	
	Bubbler No./ft³ of air	Settling plate	Bubbler No./ft³ of air	Settling plate
A, Relative humidity = 10%				
0– 5	4640	284	760	140
1– 6	7520	272	560	102
2– 7	6640	248	544	43
3– 8	5120	212	112	22
4– 9	6440	172	123	13
6–11	5280	148	21	6
10–15	5560	140	2	8
15–20	2240	109	0	0
	$K_B = 0.021$	$K_{SP} = 0.027$	$K_B = 0.288$	$K_{SP} = 0.247$
B, Relative humidity = 70%				
	Control (no glycol)		Test (glycol 25.8 γ/l)	
0– 5	4740	608	2332	496
1– 6	5000	540	2952	460
2– 7	4240	416	816	360
3– 8	4480	464	432	284
4– 9	3920	531	621	320
6–11	2700	423	280	351
10–15	2180	417	246	347
15–20	2040	319	73	275
	$K_B = 0.039$	$K_{SP} = 0.015$	$K_B = 0.082$	$K_{SP} = 0.012$

[4] $K = \frac{\text{Log } N_o - \text{log } N_t}{t}$.

K = Die-away constant.
N_o = Numbers of survivors at time zero.
N_t = Numbers of survivors at time t (in minutes).

Based upon the Stokes' equation for the velocity of turbulent settling of spherical particles show that a 10- to 35-fold increase in diameter (or a 10^3–10^5 increase in mass) would be required to give the same change in the apparent death rate of *E. coli* as that obtained in lowering the relative humidity from 70 to 50% (Table 1). Thus, both *in vitro* and in the air, the rate at which the bactericidal activity varies with changes in relative humidity or glycol concentration is much higher than the rate of change in settling velocity. Therefore, from these considerations, also, it is evident that the observed rates of action of the glycols on airborne *E. coli* are consistent with the bactericidal action of these agents and cannot be accounted for on the basis of sedimentation.

The bactericidal nature of the glycols *in vitro* can be easily demonstrated, and such action has been shown to be very dependent upon the concentration of these substances surrounding the bacterial cells. At certain levels, a change of 10% in the glycol concentration results in a 100- to 1000-fold change in the death rate (*24*). This sensitivity of the rate of bactericidal action of the glycols to minute changes in their concentration is further demonstrated in the data secured from aerosol studies (*11*). Such small changes in the concentration of glycol vapor in the air, and hence in the droplet, cannot alter the sedimentation rate by the same order of magnitude.

There are several other criteria for establishing the mode of action of the glycols. If the action is primarily due to settling, as claimed by Nagy and Mouromseff, then the decrease in the viable population of the air should give rise to an increase in the numbers of viable organisms recovered on the initial settling plates of the test experiment. The higher the rate of settling, the greater will be the number of organisms recovered on the first test settling plate. This possibility is clearly eliminated by the data shown in Tables 1 and 2, which are typical of the results obtained in more than fifty experiments. Not one instance was found in which any test settling plate gave a higher viable count than was obtained for the control plate for the same time interval.

Further, the rate of removal of bacteria from the air by settling should be independent of the type of organism studied, whereas it is generally accepted that the rate at which any bactericidal agent acts is influenced by the type of organism tested. It has been demonstrated that the bactericidal activity of the glycol vapors is dependent upon the type of organism

against which they are being employed, both in the air (*6, 11*) and *in vitro* (*24*). Finally, direct evidence of the lethal action of glycol vapor was obtained by testing the viability of microorganisms isolated by sedimentation from propylene glycol saturated atmospheres, and in no instances were any viable bacteria found (*4*).

Since it has been found that the rate of bactericidal action of glycol vapors depends directly upon the concentration of glycol in the air (Puck [*10*]), we could infer that the observed lack of lethal effect of propylene and triethylene glycol vapor for *E. coli* reported by Nagy and Mouromseff was due to insufficient glycol in their experiments. They report no determinations of glycol in the air. As Robertson (*23*), Lester *et al.* (*25*), and Bourdillon (*13*) have shown, considerable quantities of glycol vapor are lost by condensation on walls and other surfaces of the room, so that evaporation of a quantity of glycol calculated to produce saturation of a given space may result in only an insignificant fraction of such concentration. Furthermore, as was shown by Puck and Chaney (*26*), the presence of a visible fog is never in itself sufficient to prove the existence of a saturated atmosphere of glycol vapor. Hence no valid conclusions about the effectiveness of the glycols or any other bactericidal vapors can be drawn without knowledge of the concentration employed. In our experiments, conducted under optimum conditions of temperature and humidity, and employing atmospheres known to be saturated with propylene glycol, the killing of airborne *E. coli* was essentially instantaneous. Triethylene glycol acted more slowly.

Triethylene glycol vapor under similar conditions was found to be highly bactericidal against airborne *E. coli*. However, the rate of kill was demonstrably less than that observed for propylene glycol. This difference conforms to the results of *in vitro* studies (*24*) which demonstrated that, of the two agents, propylene glycol is the more rapidly acting germicide.

References

1. Robertson, O. H., *et al. Science*, **93**, 213 (1941).
2. Robertson, O. H., *et al. Trans. Assoc. Am. Physicians*, **56**, 353 (1941).
3. Robertson, O. H., *et al.* In F. R. Moulton (Ed.). *Aerobiology*. Washington, D. C.: Am. Assoc. Advance. Science, 277 (1942).
4. Robertson, O. H., *et al. J. Exptl. Med.*, **75**, 593 (1942).
5. Robertson, O. H. *Harvey Lectures*, Ser. 38, 227 (1942–43).
6. Puck, T. T., Robertson, O. H., and Lemon, H. M. *J. Exptl. Med.*, **78**, 387 (1943).
7. Robertson, O. H., *et al. Science*, **97**, 142 (1943).
8. Robertson, O. H. *Ibid.*, 495.
9. ———. *Trans. Assoc. Am. Physicians*, **58**, 171 (1944).
10. Puck, T. T. *J. Exptl. Med.*, **85**, 729 (1947).
11. Lester, Wm., Jr., *et al. Am. J. Hyg.*, **50**, 175 (1949).
12. Robertson, O. H., Lester, W., and Smith, M. *Ibid.*, **53**, 69 (1951).
13. Bourdillon, R. B., Lidwell, O. M., and Lovelock, J. E. *Med. Research Council (Brit.), Special Rept. Ser. No. 262* (1948).
14. De Ome, K. B. *Am. J. Hyg.*, **40**, 239 (1944).
15. Bigg, E., and Mellody, M. *J. Infectious Diseases*, **79**, 45 (1946).
16. Potter, T. S. *Science*, **99**, 406 (1944).
17. Nagy, R., and Mouromseff, G. *Ibid.*, **112**, 593 (1950).
18. Robertson, O. H., Puck, T. T., and Wise, H. *J. Exptl. Med.*, **84**, 559 (1946).
19. Sonkin, L. S. *Am. J. Hyg.*, **51**, 319 (1950).
20. Kaye, S. *Anal. Chemi.*, **22**, 661 (1950).
21. Wise, H., Puck, T. T., and Stral, H. M. *J. Biol. Chem.*, **150**, 61 (1943).
22. Lemon, H. M. *Proc. Soc. Exptl. Biol. Med.*, **54**, 298 (1943).
23. Robertson, O. H. *Wisconsin Med. J.*, **46**, 311 (1947).
24. Robertson, O. H., *et al. J. Infectious Diseases*, **83**, 124 (1948).
25. Lester, W., *et al. Am. J. Pub. Health*, **40**, 813 (1950).
26. Puck, T. T., and Chaney, A. L. *Ind. Hyg. Assoc. Quart.*, **7**, 10 (1946).

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Comments and Communications

On Leukotaxine

As pointed out in numerous publications, inflammation is a manifestation of severe cellular injury in vertebrates (*1*). It has also been pointed out that any irritant injures the cell, and injury alters the biochemistry of the cell, with consequent release of various common denominators (*1*, p. 135, footnote). These common denominators include leukotaxine, the leukocytosis-promoting factor (thermolabile and thermostable), necrosin, pyrexin, and leukopenic factor, leukopenin, and the more recently described exudin (*2*). These factors, or common denominators, are responsible for the fundamental, stereotyped reaction of inflammation. It is incorrect to state that one of them alone, and not all of them or some of them, initiate acute inflammation, as Moon asserts that the writer claims (*3*).

It has often been pointed out that the cells, when injured, liberate leukotaxine, and only when injured do they form this substance. Even a diagram of this process appears in a recent monograph (*1*, p. 123). It would be difficult, therefore, to envisage that normal tissue cells as such would contain leukotaxine. In recent studies Moon has questioned the hypothesis on the ground that leukotaxine has not been shown to exist in normal tissue (*3*). One would not expect to find it in perfectly normal cells. Moon presents absolutely no evidence supporting the view that leukotaxine does not exist in normal tissue (*3*). His own studies indicate that a chemotactic substance is possibly present in damaged tissue; and this substance does not necessarily come from exudate where leukotaxine had originally been recovered. Moon obtained a quantity of muscle from a freshly killed rabbit and ground the material in a meat chopper. A saline extract was then made. Similar extracts were made from kidney, liver, skin, and lung. These extracts were then injected intradermally into the ears of rabbits, and

the lesions were studied (*3*). As pointed out in earlier studies, macerating tissue as Moon has done is the best way to injure cells and thus liberate leukotaxine. This has been shown by the writer to occur with macerated testicular extract, from which a permeability factor has been obtained (*4*). Rigdon has shown the presence of a similar permeability factor, which is one of the properties of leukotaxine, with saline tissue extract of skin, muscle, and testicle (*5*). The writer has recently shown that any cells from invertebrates and also from dogs, when crushed, will yield necrosin, as obtained in exudate (*6*). One must recall that an exudate represents the products of cell injury admixed with elements from the blood. The severely injured cells, however, as obtained from extracts by crushing or mashing previously normal cells, yield the same factors as obtained from exudate.

Lewis termed the substance from injured tissue the "H-substance," presumably because it was either histamine or was closely allied to it (*7*). Leukotaxine has no common property with histamine either biologically or chemically (*8*). This fact accounts for the term leukotaxine. No one knows where in the cell, or in which type of injured cell, leukotaxine is formed. In spite of Moon's statement, the writer has never stated that leukotaxine is derived from leukocytes (*9*). Therefore, the term proposed by Moon of "cytotaxine" is unwarranted by the known facts (*3*). Finally, as pointed out in a recent discussion (*9*), instead of being reluctant to accept the term leukotaxine, it would greatly facilitate the discussion if Moon would chemically prove whether leukotaxine is present in the experimental types of inflammation he has studied. He states: "It is our impression that the tissue substance which produced the effects maintained is not a specific chemical entity, although this belief is not based on chemical evidence" (*3*). It is the writer's firm belief that Moon's studies merely indicate that he has substantiated earlier workers who postulated the presence of a substance which is liberated by damaged cells and which is in turn chemotactic. The concrete chemical studies of the writer have demonstrated the presence of such a chemical substance in the product of cell injury, and this substance he has termed leukotaxine (*10*). The presence of leukotaxine has been confirmed separately by Duthie and Chain (*11*), Cullumbine (*12*), Minami and Inugami (*13*), Pasquali (*14*), and by Yeshuri (*15*).

VALY MENKIN
Temple University School of Medicine, Philadelphia

References

1. MENKIN, V. *Newer Concepts of Inflammation.* Springfield, Ill.: Thomas (1950).
2. ———. *Am. J. Physiol.*, **166**, 509 (1951).
3. MOON, V. H., and TERSHAKOVEC, G. A. *Arch. Path.*, **52**, 369 (1951).
4. MENKIN, V. *Ibid.*, **24**, 65 (1937).
5. RIGDON, R. H. *Arch. Surg.*, **41**, 96 (1940).
6. MENKIN, V. *Proc. Soc. Exptl. Biol. Med.*, **75**, 350 (1950).
7. LEWIS, T. *The Blood Vessels of the Human Skin and their Responses.* London: Shaw and Sons (1927).
8. MENKIN, V. *Physiol. Revs.*, **18**, 766 (1938); *Dynamics of Inflammation.* New York: Macmillan (1940).
9. MOON, V. H., and TERSHAKOVEC, G. A. *Am. J. Path.*, **27**, 693 (1951).
10. MENKIN, V. *J. Exptl. Med.*, **67**, 129, 145 (1938).
11. DUTHIE, E. S., and CHAIN, E. *Brit. J. Exptl. Path.*, **20**, 417 (1939).
12. CULLUMBINE, H., and RYDON, H. N. *Ibid.*, **27**, 33 (1946).
13. MINAMI, G., and INUGAMI, K. *Trans. Soc. Path. Japon.*, **30**, 389 (1940).
14. PASQUALI, L. *Ricerche e studi med. sper.*, **18**, 209 (1947).
15. YASUHIRA, K. *Acta Path. Japon.*, **1**, 7 (1951).

I APPRECIATE the opportunity to comment on Dr. Menkin's communication. It is not unusual for workers to disagree in their evidence and interpretations. Often this is desirable, for it emphasizes the fact that the problem is not yet solved, and that further evidence should be sought and published. Failure to agree should not arouse controversial antagonism. If the questioned interpretation is correct, it will be reinforced by further investigation; if incorrect, then it is fortunate that the question was raised. I am content to allow our colleagues to judge the merits of both viewpoints.

Many of our critic's assertions are not factual, and most of his objections are invalid. A few instances will be cited.

Our statement regarding the origin of leukotaxine is misquoted. We said (*1*): "He [Menkin] subjected inflammatory exudates obtained from suppurative pleuritis to chemical cleavage. By fractionation and purification, he obtained a crystalline substance which he termed leukotaxine."

Without substantial evidence, Menkin asserts that leukotaxine is present in all normal tissues, that it is liberated from them when injured, and that maceration is the best way to do this. Therefore, he reasons that the extracts used in our experiments owe their effects to leukotaxine. His position would be fortified by isolating leukotaxine from muscle, skin, lung, liver, kidney, and others. Why has he not done this? If these tissues present an easily available source for leukotaxine, why was it necessary laboriously to produce suppurative exudates as a source of material for his studies?

Dr. Menkin protests against our allusion to leukotaxine as the one factor claimed by him to be responsible for inflammation. Yet in the recapitulation of his book *The Dynamics of Inflammation* (pp. 204–206), he attributes the major phenomena of inflammation, including capillary permeability and migration of leukocytes, to leukotaxine—*"which appears* [italics mine] as if it *may* belong to the group of relatively simple polypeptides." No other factor is mentioned here.

Subsequently, he postulated sundry additional factors: necrosin, pyrexin, leukopenin, exudatin, and two leukocytosis-promoting factors. Numerous substances of animal origin will cause fever, necrosis, and leukopenia. One wonders by what criteria these can be distinguished from Menkin's pyrexin, necrosin, and leukopenin. Many pathologists have found this multiplicity of hypothetical factors to be confusing rather than clarifying. The chemical structure is undetermined, yet our experiments are criticized for

lack of chemical identifications. We should be told the chemical nature of these substances and criteria for distinguishing them before identification is required.

Rigdon (*2*) merely concluded: "A substance has been obtained from the skin, muscle and testicles of normal rabbits which produces a local increase in capillary permeability." By what logic does Dr. Menkin assume that this substance is leukotaxine? With equal logic he might assume that histamine—which increases capillary permeability—is leukotaxine.

The statement "Leukotaxine has no common property with histamine, either chemically or biologically" is not factual. Histamine causes both dilatation and permeability of capillaries. Menkin claims that leukotaxine has these same properties.

Duthie and Chain (*3*) found in extracts of liver, kidney, and muscle substances that increased capillary permeability. They devised a method whereby a polypeptide was obtained from fibrin by peptic digestion. This product was strongly chemotactic; it caused increased capillary permeability and leukocytic infiltration in the skin of animals. A polypeptide having similar properties was obtained from Witte's peptone and from many proteins. These workers were convinced that they were dealing with a general physiologic action of protein breakdown products. They were unable to establish a chemical relationship between these products and leukotaxine, and doubted that the claim that leukotaxine is a polypeptide has been established. Yet Menkin cited these authors, Rigdon, and others as having corroborated his findings.

The most valid criticism leveled at our report is that it substantiates the conclusions of earlier workers. This, we humbly admit, *it does*.

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References

1. MOON, V. H. *Arch. Path.*, **52**, 370 (1951).
2. RIGDON, R. H. *Arch. Surg.*, **41**, 96 (1940).
3. DUTHIE, E. S., and CHAIN, E. *Brit. J. Exptl. Path.*, **20**, 417 (1939).

Scientific Book Register

Archaeological Survey in the Lower Mississippi Alluvial Valley, 1940–1947. Papers of the Peabody Museum of American Archaeology and Ethnology, Harvard University, Vol. XXV. Philip Phillips, James A. Ford, and James B. Griffin. Cambridge, Mass.: Peabody Museum, Harvard University, 1951. 472 pp. and 32 plates. $8.50.

The Oxide-Coated Cathode, Vol. 1: ***Manufacture;*** Vol. 2: ***Physics including Thermal Emission from Metals and Semi-Conductors.*** G. Herrmann and Phil S. Wagener; trans. from the German by Phil S. Wagener. London: Chapman & Hall, 1951. Vol. 1: 148 pp., 21s; Vol. 2: 311 pp. 42s.

American Weasels. Museum of Natural History, Univ. Kansas Pubs., Vol. 4. E. Raymond Hall. Lawrence: Univ. Kansas, 1951. 466 pp. incl. 41 plates. Exchange publication.

The Thermodynamics of the Steady State. K. G. Denbigh. London: Methuen; New York: Wiley, 1951. 103 pp. $1.75.

Problems of Consciousness. Transactions of the Second Conference, March 19–20, 1951, New York. Harold A. Abramson, Ed. New York: Josiah Macy, Jr. Fdn., 1951. 178 pp. $3.25.

The Chemistry of Synthetic Dyes, Vol. I. K. Venkataraman. New York: Academic Press, 1952. 704 pp. $14.50.

Vegetation of the Sonoran Desert, Pub. 591, Vol. I. Forrest Shreve. Washington, D. C.: Carnegie Institution, 1951. 192 pp. and 37 plates. $3.25; cloth, $3.75.

Substances Naturelles de Synthèse: Préparations et Méthodes de Laboratoire, Vol. III. Léon Velluz, Ed. Paris: Masson, 1951. 156 pp. 1400 fr.; bound, 1750 fr.

Principles of Lighting. W. R. Stevens. London: Constable; New York: Longmans, Green, 1951. 482 pp. 35s.

Science: Sense and Nonsense. J. L. Synge. New York: Norton, 1951. 156 pp. $2.75.

The Enzymes: Chemistry and Mechanism of Action, Vol. II, Part 2. James B. Sumner and Karl Myrbäck, Eds. New York: Academic Press, 1952. Pp. 791–1440. $14.00.

Application of the Electronic Valve in Radio Receivers and Amplifiers, Vol. II. B. G. Dammers *et al.* Eindhoven: Philips' Technical Library, 1951. U. S. distrib.: Elsevier Press, Houston. 450 pp. $7.75.

French-English Science Dictionary. For students in agricultural, biological, and physical science; with a supplement of terms in aeronautics, electronics, radar, radio, television. 2nd ed. Louis De Vries. New York–London: McGraw-Hill, 1951. 596 pp. $6.50.

Radioactivity Applied to Chemistry. Arthur C. Wahl and Norman A. Bonner, Eds. New York: Wiley; London: Chapman & Hall, 1951. 604 pp. $7.50.

Graphic Aids in Engineering Computation. Randolph P. Hoelscher, Joseph Norman Arnold, and Stanley H. Pierce. New York–London: McGraw-Hill, 1952. 197 pp. $4.50.

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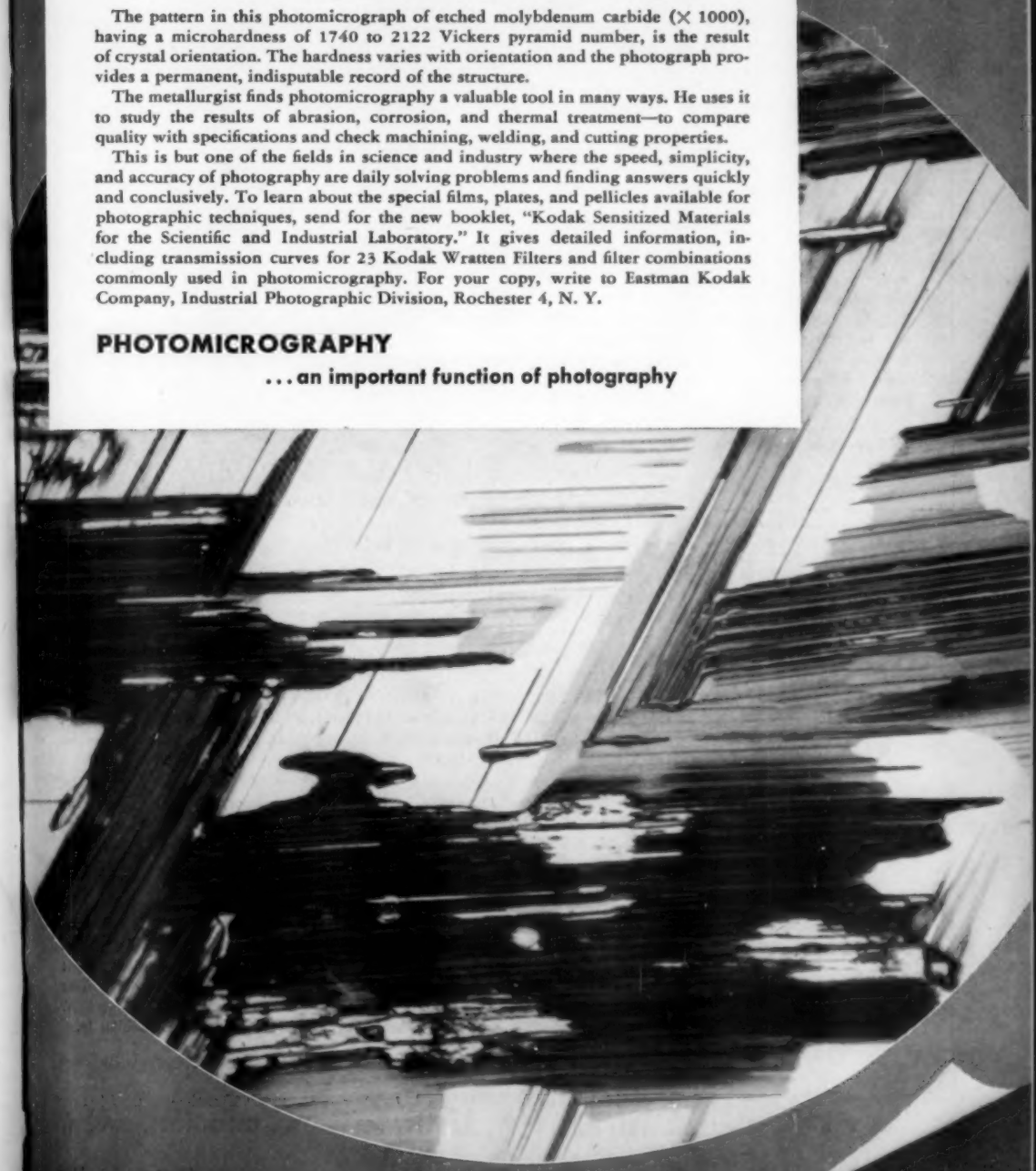

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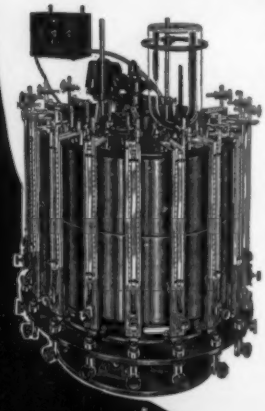

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Carnegie Institution of Washington: Year Book No. 50. Carnegie Institution of Washington. Baltimore: Lord Baltimore Press, 1951. 260 pp. $1 paper; $1.50 cloth.

The Clarke School for the Deaf: Eighty-Fourth Annual Report. Northampton, Mass.: Metcalf Printing and Publishing Co., 1951. 65 pp.

Commonwealth Scientific and Industrial Research Organization, Australia: List of publications. Melbourne: 1951. 31 pp.

The Conceptual Framework of Psychology: International Encyclopedia of Unified Science, Vol. 1, No. 10. Egon Brunswik. Chicago: Univ. Chicago Press, 1952. 102 pp. $2.00.

Control and Removal of Radioactive Contamination in Laboratories: National Bureau of Standards Handbook 48. Washington: GPO, 1951. 24 + iv pp. 15¢.

E. I. du Pont de Nemours & Company: Annual Report for the Year 1951. 42 pp. Wilmington, Del.

An Experiment in Architectural Education through Research: Research Rept. No. 32. Gordon McCutchan and William W. Caudill. Texas A. and M. College System. College Station: Texas Engineering Experiment Station, 1951. 64 pp.

Fuel and Power in Captive Middle Europe. Jan H. Wszelaki. New York: Mid-European Studies Center of the National Committee for a Free Europe, Inc., 1952. 63 pp. 25¢.

Georgia Warm Springs Foundation Annual Report. Warm Springs, Georgia, 1951.

The Hodograph Method in Gas Dynamics. A. G. Ghaffari. Tehran: Taban Press, 1950. 129 pp.

Publicaciones del Centro de Investigaciones Tisiológicas, Vol. XV. Roque A. Izzo, Director. Buenos Aires: Centro de Investigaciones Tisiológicas, Hospital Tornú, 1951. 257 pp. (Summaries in Spanish, French, English, German.)

Purse Seines and other Roundhaul Nets in California. Fish Bull. No. 81. W. L. Scofield. 83 pp. Illus.; ***A Comparison of the Populations of Yellowfin Tuna, Neothunnus macropterus, from the Eastern and Central Pacific.*** Fish Bull. No. 82. H. C. Godsil and E. C. Greenhood. 33 pp.; ***Age Composition of the Southern California Catch of Pacific Mackerel 1939–40 through 1950–51.*** Fish Bull. No. 83. John E. Fitch. California: Bur. Marine Fisheries, 1951. 73 pp. Illus.

Research and Service in Multiple Sclerosis. First Annual Report, Oct. 1946–July 1951. New York: National Multiple Sclerosis Society, 1951. 27 pp.

Selection, Training, and Use of Personnel in Industrial Research. Proceedings of the second annual Conference on Industrial Research sponsored in June 1951, by the Dept. of Industrial Engineering, Columbia University. David B. Hertz, Ed. New York: King's Crown Press, 1952. 274 pp. $4.50.

United Nations—World Cartography, Vol. I. New York: Dept. of Social Affairs, United Nations, 1951. (U. S. distrib.: Columbia Univ. Press, 2960 Broadway, New York 27.) 107 pp. Illus. $1.25.

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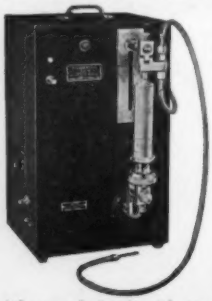

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Apr. 21–24. Society of Automotive Engineers (National Aeronautic Meeting and Aircraft Engineering Display). Hotel Statler, New York.

Apr. 21–25. American College of Physicians (Annual). Public Auditorium, Cleveland.

Apr. 21–25. Society of Motion Picture and Television Engineers (Semiannual). Drake Hotel, Chicago.

Apr. 21–26. Educational Television Programs Institute. Nittany Lion Inn, Pennsylvania State College.

Apr. 22–24. American Industrial Hygiene Association. Cincinnati.

Apr. 22–24. Society of Chemical Industry Conference on Adhesion. Leeds.

Apr. 22–26. International Congress of Otoneuro-Ophthalmology. Lisbon and Estoril, Portugal.

Apr. 23–26. National Association of Foreign Student Advisers. East Lansing, Mich.

Apr. 24–25. American Academy of Neurology. Brown Hotel, Louisville, Ky.

Apr. 24–25. Pennsylvania Manufacturing Confectioners' Association (Annual Production Conference). Lehigh University, Bethlehem.

Apr. 24–26. American Philosophical Society (Annual). Philadelphia.

Apr. 25–26. American Mathematical Society (Eastern), Columbia University, New York; (Western), University of Chicago.

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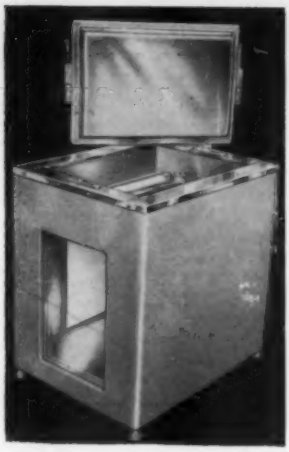

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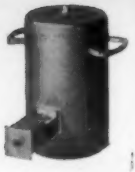

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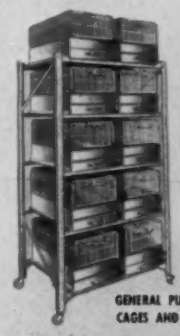

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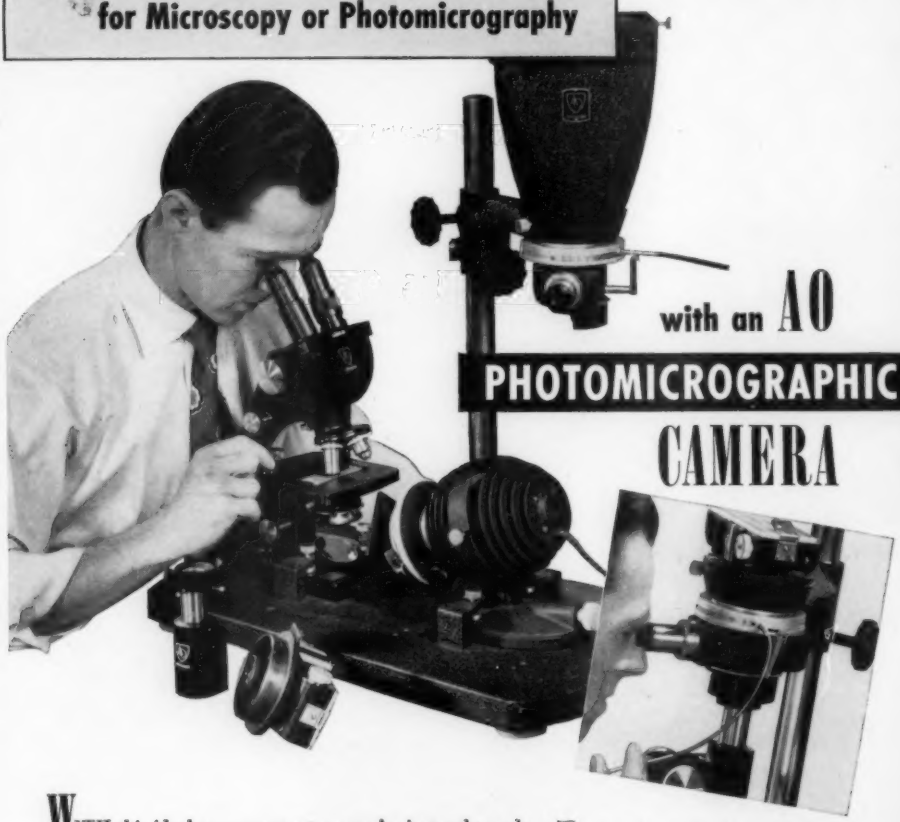

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